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THE INTEGRITY OF SCIENCE

PROF. A. V. HILL'S presidential address to the British Association (see p. 388) takes up as a challenge the concluding paragraph of his predecessor's address at Edinburgh. "It is clearly our duty as citizens to see that science is used for the benefit of mankind. For, of what use is science if man does not survive ?" With those words as a text, Prof. Hill proceeds to discuss how far science has already contributed to human betterment, how far it has provided fresh problems, dangers and difficulties, and to suggest ways in which all who are concerned with science can help, as citizens, to make sure that its results, in fact, are beneficial.

Prof. Hill promptly disclaimed for scientists as such any title to superior wisdom or virtue, but proclaimed uncompromisingly that the fundamental principle of scientific work is unbending integrity of thought, following the evidence of fact wherever it may lead, within the limits of experimental error and honest mistake ; and since science is a universal interest of mankind, recognizing no barriers of race, class, religion or honest opinion, a necessary condition of scientific advance is goodwill, friendliness and frankness. There is more to science than integrity and goodwill, but these are the qualities chiefly required to utilize the opportunities, and to resolve the problems and difficulties which science has provided for society to-day.

Prof. Hill's address amply illustrates the truth of his own words. Denunciation is unlikely to follow his exercise of the right he claims to discuss not only scientific facts themselves but also their consequences in human affairs ; but his address may well provoke controversy, though scarcely comparable with that provoked by Tyndall's presidential address to the Association in Belfast seventy-eight years ago. When new knowledge and traditional beliefs are in conflict men are apt to forget Lord Kelvin's words : "Science is bound by the everlasting law of honour to face fearlessly every problem that can fairly be presented to it".

In reading Tyndall's address to-day, one is impressed, as Prof. Hill remarked, by its reasonableness as well as by its courage. Even when the Association next met in Belfast, in 1902, Tyndall's claim that science would wrest from theology the entire domain of cosmological theory had been practically conceded. Tyndall's words were then seen in their proper context and he was recognized, as Dewar pointed out in his presidential address that year, as no mere materialist, but one who recognized the immovable basis of the religious sentiment in human nature, bringing completeness and dignity to man. Tyndall had admitted that the whole process of evolution is the manifestation of a power absolutely inscrutable to the intellect of man, and acceptance of the necessary limits of scientific inquiry was then perhaps more common than it sometimes is to-day, while his dictum that "every system must be plastic to the extent that the growth of knowledge demands" might equally have formed the text for Prof. Hill's address.

In fact, where we encounter what Prof. Hill calls the ethical problems presented by the advance of science there has been little change in the degree of objectivity with which questions are discussed. It will be noted that, while Prof. Hill starts from the concluding words of the Duke of Edinburgh's address, he promptly applies a corrective to any careless thinking that the Duke's earlier words as to the dependence of progress in almost every form of human activity upon the continued efforts of scientists might engender. "The improvement of man's estate by the application of human knowledge," said Prof. Hill, "is one of the loftiest of adventures: but a belief that it can be achieved by scientific methods alone, without a moral basis to society, is a perilous illusion." Prof. Hill then pointed out, frankly and fearlessly, some of the implications and consequences of advances in public health and sanitation and the control of disease which are often ignored by those framing plans for the development of backward and other areas, such as the Colombo Plan.

Not only is the population increasing but in many places the rate of increase is still rising. In India, a Government Planning Commission in a report of July 1951, "The First Five-Year Plan", dared to point out that, with all the effort that this Plan represented, it would be barely possible to restore by 1955–56 the pre-war standards in regard to food and clothing. Increasing pressure of population on natural resources in retarding economic progress and limiting seriously the rate of extension of social services so essential to civilized existence. Meanwhile there is more than danger that the emergency will result in an over-use of natural resources, leading by land erosion, deforestation and other factors to permanent and irretrievable loss.

This has already happened and is visibly happening now in many parts of the world. With a frankness to which Prof. Hill paid tribute, the Indian Report suggests the education of public opinion on the need for limitation, but it recognizes also that an alteration in population trends takes at least a few generations to materialize. Meanwhile the combating of malaria with insecticides and anti-malarial drugs, of tuberculosis and cholera and other diseases, and the improvement of rural and industrial health, must be recognized as involving a further addition to the population of a million people per annum. Biological, medical, chemical and engineering science, applied for motives of humanity, with no objectionable secrecy, has thus led to a problem of the utmost gravity, demanding for its solution all the resources of science, humanity and statesmanship.

Prof. Hill's address should dispose of the comfortable illusion that it is merely a matter of food supply. The demands which a higher standard of living and an increasing population make on all natural resources are equally disturbing. Prof. Hill has the courage to face the unpleasant but inescapable questions of what reasonable limits are to be placed on human rights, and whether such rights extend to unlimited reproduction while those concerned are screened from its consequences by the discipline and care of others. Such questions have to be faced with courage and honesty and without prejudice. They will not be solved by words or by temporization.

By taking as example one in which the motives of those who made the original discoveries or the humanity of their applications can scarcely be called in question, Prof. Hill made clearer the ethical dilemma implied in such questions as the limits, if any, which should be placed on scientific research and the authority which should determine any such limits, and the wisdom of insisting that all scientific knowledge should be fully and openly disclosed without secrecy or reservation of any kind, military or industrial. The somewhat arid discussions regarding secrecy in nuclear physics are set by him in the wider context of the standards and principles without which civilization would be permanently and indefinitely poorer. If ethical principles deny our right to do evil in order that good may come, are we justified, he asks, in doing good when the foreseeable consequence is evil? Suppose it is certain now that the pressure of increasing population, uncontrolled by disease, will lead not only to widespread exhaustion of the soil and of other capital resources, but also to continuing and increasing international tension and disorder, making it hard for civilization itself to survive, what then should be our policy?

Books like "Four Thousand Million Mouths", "The Geography of Hunger" and "Soil and Civilization", as well as some discussions on the development of backward areas, have made many in recent months aware of the danger. The ethical dilemma could scarcely be more frankly or better stated than in Prof. Hill's address. Moreover, not the least of its merits is that, following the pattern of the Duke of Edinburgh's address last year, it helps further to dispel the idea that science and technology are magical or mysterious activities, apart from the ordinary occupations of men and women and beyond their comprehension.

That Prof. Hill's address thus contributes to a clearer understanding by the ordinary citizen of the nature of scientific work, and especially of the extent and limits of the scientist's responsibility, is the more important because the address is first and foremost a summons to frank and free discussion. Such discussion should be the freer from prejudice on this account, and it is to be hoped that it will be marked by both the courage and the integrity for which Prof. Hill appeals, to the layman no less than to the scientist. The dilemma is, as he shows, not one peculiar to the scientist: it is one which the scientist shares with his fellow citizens, and besides making plain to the general public the position of the scientist, Prof. Hill insists that to help to guide the use of scientific discovery aright is the honourable and compelling duty of a good citizen, whether or not he be also a scientist.

The first need is full and free discussion; but care should be taken to see that this is not provoked in ways that hinder the co-operation between science and religion, between the scientist and his fellow citizens upon which, like Tyndall, Prof. Hill insists.

Such co-operation is only possible on the basis of courage and integrity, and his address is full of implications both for the conduct of political life as well as for the scientist. Moreover, remarks that read almost as asides to the scientist in the address are related closely to this question of co-operation. The warning that the use of the general prestige of science as a bait to attract attention to pronouncements on other topics is a disservice both to science and to the public has its implications for the layman as well as the scientist, but bears very closely on the question of mutual confidence on which co-operation largely depends.

From this point of view Prof. Hill's remarks on the problem of secrecy in such matters as nuclear research and his practical suggestions to scientists should be noted. They are entirely relevant to his main theme. By considering the ethical basis of their work and frankly discussing the moral considerations which enter in, scientists will go far to establish a confidence in their responsibility and integrity which some recent episodes have shaken, but which is the only possible basis for the co-operation and understanding which can reduce these grave problems to manageable dimensions.

Controversial though some of the issues this address raises may be, it is marked by the same reasonableness and courage that characterized Tyndall's earlier address, and its humane outlook and keen sense of moral and ethical values, no less than the modesty and integrity of its thought, should at least prevent controversy from being embittered. Prof. Hill has shown the right way to approach these acute and dangerous problems of population and world order and the utilization of world resources. He indicates clearly the limits of the scientist's responsibility, as too, he impresses on the scientist the need for clear thinking about the ethical basis of his work.

His appeal for responsible discussion is addressed to scientist and layman alike. How far the co-operation he urges will prove effective it is impossible to say. There are too many examples of the way in which religious or national prejudices can override the rational discussion of problems of welfare and development, even to their own immediate material disadvantage, to be over-optimistic, even without regard to the immense cost and effort required for an education campaign which would equip the backward peoples of the world to meet some of the demands for self-discipline which the situation requires. Nor is education alone adequate to supply the moral qualities which such self-discipline implies, as we can plainly see in our own and other Western nations.

But without such co-operation there can be no approach made to the solution to the grave problems Prof. Hill passed in review. Co-operation between layman and scientist, as good citizens in the discharge of a common responsibility and in the formation of those judgments of value which in the end determine the use we make of science, is the first step. Ultimately the problem we have to solve, whether as scientist or as layman, is one in the responsible exercise of power, and its solution depends on whether man, having learned to command Nature, can now learn to command himself before he destroys civilization.

To do this is, in Tyndall's phrase, to gain "completeness and dignity", and success depends, as Prof. Hill clearly indicates, not on our resolution of some special ethical dilemma, peculiar to scientific men, but rather on the resolution of the so-called conflict between religion and science. It calls for the use of science to express and apply the principles of ethics, and the use of those principles to guide the conduct of scientific men. In the appreciation of what is good and beautiful, Prof. Hill finds for layman and scientist the vision that can encourage both in the task to which his address summons them.

REPORTING SCIENCE

THE scientific thought of the Western civilization is as much a part of our culture as the developments in the humanities which originated in the Greek and Jewish writings and were nurtured and grew in the centuries of the Christian era. But science, if only in some of its technological manifestations, touches and even moulds the lives and destinies of those who are not interested in culture in its narrow sense. Each year the problem of reporting the results and implications of scientific discovery becomes at once more important and more difficult, but only by communication can we have a true community. It is more important because more of our fabric of living, individually and socially, is dependent on the application of science, and more difficult because, with the increase in the techniques employed by men of science, there has been an increase in the number and complexities of scientific modes of expression. Not only new words and phrases, but also new symbolisms and mathematical calculi are part of the current linguistics of science. Even some of the simplest of processes and expressions used in the calculus of statistics, so valuable in the biological sciences with their applications to human needs, involve great logical difficulties, both mathematical and verbal, for all but comparatively few people.

Because of the present shortage of well-qualified science teachers, even many children who are prepared to take science for the General Certificate of Education (and this is not a large proportion in view of the needs) are not in their adolescent and adult life prepared to understand the significance of the new discoveries of science. In the whole field of adult education in Britain, classes in the sciences account for only 7 per cent of the whole number. Although it is difficult to find suitable tutors, sufficiently well-read in the sciences, and skilful enough as teachers and leaders in adult classes, there still remains the fact that science is not popular, in the true sense of the word, with adults.

The task of explaining science to those whose work lies in some other field is not a new one. In 1633, Phineas Fletcher wrote "The Purple Island" in which he versified physiology. Erasmus Darwin,

always optimistic concerning the scientific education of the "ordinary" man, produced "The Botanic Garden" (1789) in rhyme. Fortunately such poetical attempts have not often been followed up, though writers such as Auden have attempted to illuminate the picture of the scientific environment with poetic insight. More than in any other country, British men of science have been able to write clearly and elegantly in their mother tongue. Many have produced work which, quite apart from any scientific significance, has also literary merit. The nineteenth-century writings of Tyndall, Lyell and Charles Darwin still stand as literature. Those of Francis Bacon, Robert Boyle, T. H. Huxley and Gilbert White, to mention a few at random, can be read with pleasure and sometimes with ease. Coming nearer to our times the books in Britain of James Jeans, A. N. Whitehead and J. W. N. Sullivan, whose early death was a great loss to scientific literature, and in the United States the works of Beebe, Sears and, very recently, Rachel Carson, are examples of a good type of vulgarization of science. Nearly all of these writers were men of science.

But what of the reporter who is not a scientific worker, but whose task it is to present news which has to compete in popularity with other forms of news designed to attract public interest and to hold it at any rate until something at least as interesting appears? It would be trite to say that his contribution both in content and emphasis must vary with the type of reader for which his paper caters. It is significant that the only reference in several of our national papers to some dozens of important discourses given during one of the days of the meeting of the British Association for the Advancement of Science in Edinburgh last year was the fact that an important paper on coal supplies had been interrupted with asperity by a "local resident". No doubt this unseemly incident was much better news to those who love sensationalism than a carefully conceived account of the tremendously important fuel and power problem as it will confront our children. It is impossible to blame the reporter or his paper. The matter always returns to the fundamentals of popular education, its contents and its aims.

In the United States, where there is a much greater demand for books and articles on science, and probably also a larger percentage of people who are interested in science, or at least in technology, the reporting of science has had more consideration as to its aims and nature and more organization than it has in Britain. Most of the American writers who report science for newspapers and magazines belong to the National Association of Science Writers which was founded in 1934 for the express purpose of promoting accurate and responsible science reporting. The membership at the present time is upwards of 150. The National Association of Science Writers is affiliated with the American Association for the Advancement of Science.

American publishers and editors say that they have found that it is better to train experienced reporters in science rather than to hope to find sufficient men of science who are able or free to undertake this type of work. Incidentally, the proper reporting of such incidents as a fire, where there is a sequence of observable events, is said to be part of a suitable training of such a reporter; for not only is it necessary to take cognizance of a developing phenomenon to observe true chronology in a chain of events, but the reporter must also bring to his work an arresting and lively style of writing which will make his 'contribution' compete with that of other news.

Whether he likes it or not, the man of science is making history and his work should be explained as such.

A number of our American contemporary *Science* (April 18, 1952) says "good science reporting could help science itself by explaining research projects to a public that ultimately pays many of the bills. Thanks to accurate reporting of medical and public health news in newspapers and magazines during the past few decades, the general public should be fairly well informed on such matters. . .".

Yet with less organization and less advertisement, the quality of writing on science is probably better in Britain than in any other country. There can be no doubt that the American Rachel Carson's "The Sea Around Us" is a good work; but it is, to say the least, no better than the excellent British works, "The Ocean", by F. D. Ommaney, and "The Seas", by F. S. Russell and C. M. Yonge, which is splendidly illustrated in colour. Why is the first a best-seller, and why did the last have to wait eight years before a second edition appeared? The answer is probably to be found in advertisement, a matter which is anathema to most men of science.

In the end, charm they never so wisely, the work of the best science writers will be ineffective unless it is prepared for by a more general and lively teaching of science in all types of secondary school, and in this connexion here is No. 1 priority.

BIRD PARASITES

Fleas, Flukes and Cuckoos

A Study of Bird Parasites. By Miriam Rothschild and Theresa Clay. (New Naturalist Series.) Pp. xiv+304+40 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1952.) 21*s*. net.

THE avowed aim of the New Naturalist Series is to interest the general reader in the wild-life of Britain, and the present volume is an outstanding example of the way in which a somewhat specialized branch of natural history—often regarded as 'not quite nice'—can be made of absorbing interest not only to the professional zoologist and amateur naturalist but also to the general reader. The authors, both distinguished for their work in different fields of parasitology, have selected the most intensively studied animals of the world—birds—as the starting point for the development of a picture of the vast network of organisms which they harbour both inside and outside their bodies. This community of parasites comprises animals, plants, bacteria and filterable viruses, whose relationships, life-histories and general biology are very little known.

It is rather surprising that parasitology, a subject presenting so many fields for investigation, should not have received more attention—at least in Great Britain—for parasites comprise a far greater number of both species and individuals than their hosts. The taxonomist will find in them a very wide range of interest, for to take only one example, the 500-odd British birds support very many thousand different parasites, including at least 1,500 species of Mallophaga, few of which have valid scientific names. Certain groups of parasites have been used for trying to demonstrate the true systematic relationships of their hosts. The Mallophaga, for example, are highly host-specific, each species being confined to some particular host, and their evolution has resulted in related birds for the most part harbouring related Mallophaga. Similarly each order of birds has its own particular cestode fauna, and the fact that grebes and divers harbour quite distinct tapeworms suggests that these two groups of birds should not be placed together in any natural scheme of classification.

The life-cycles of such parasites as trematodes, cestodes and nematodes are strange and wonderful, generally involving perilous journeys through different hosts, with a survival-rate from egg to adult of much less than one in a million. Yet, as pointed out by the editors of this series, there is not even one worker in Britain wholly occupied with the trematodes or flukes.

The physiology of most parasites is completely unknown; but the little information which is available suggests the existence of highly specialized metabolisms well worth the study of biochemists.

The authors include a general introduction in which parasitism, commensalism, symbiosis, the effect of parasites on their hosts and parasitism on parasites, and related problems are discussed. After dealing with the various groups of parasites, ranging from micro-organisms to the arthropods, including a chapter on the fauna of birds' nests, there is an account of the brood parasitism in the European cuckoo.

The authors are to be congratulated on the production of a book combining so pleasingly both wit and erudition; it should certainly find a place in every naturalist's library.

E. HINDLE

GENETICAL STUDY OF EVOLUTIONARY PROCESSES

Genetics and the Origin of Species

By Prof. Theodosius Dobzhansky. (Columbia Biological Series, No. 11.) Third edition, revised. Pp. xi+364. (New York: Columbia University Press; London: Oxford University Press, 1951.) 32*s.* 6*d.* net.

IT is good to see a new edition of Prof. Dobzhansky's "Genetics and the Origin of Species". The previous edition appeared in 1941, and in ten years a great deal can occur in so active a science as the genetical study of evolutionary processes. The many who valued Dobzhansky's earlier editions will look to the new one for an equally informative account of the position as we see it to-day.

The basic principles of the genetical theory of evolution are, of course, unchanged. This theory rests on the postulates that heritable variation occurs in populations of living things and that, as a consequence, the populations may undergo permanent changes. So in seeking to understand how adaptation and evolution come about, we must inquire into the nature, occurrence and origin of variation in natural populations; into the ways in which heritable variants bring about changes in the structures and properties of these populations; and into the means by which they come to be fixed, both uniformly within populations and differentially between them. In that it is explicitly built round these principles, Dobzhansky's third edition is like its predecessors; but in seeking to take into account the developments of the past decade it has had to be almost completely rewritten.

Ten years ago the discussion of variation centred on mutation and especially on the occurrence of changes which were either visible in the chromosomes themselves or, if genic in nature, produced drastic effects on the phenotype. The growing realization of the importance of continuous variation has moved the emphasis towards the storage of variability, the properties of balance, and the relations they bear to recombination. Dobzhansky's own experimental work has made a major contribution to this development and indeed his studies of variation and balance in wild *Drosophila*, summarized in the new edition, have an elegance and finality which few can fail to admire. All this is reflected in the book, the old being condensed and the new brought out, with perhaps that trace of conservatism understandable in a work which is likely to be so widely quoted.

In discussing selection, Dobzhansky is now able to draw on a much greater wealth of experimental evidence, including, as in the case of mutation, information from micro-organisms. As a consequence, drift, though by no means forgotten, looms less heavily in the consideration of agencies affecting the fate of variants in wild populations. Indeed the part played by drift is necessarily seen in a different perspective when considering the properties of systems of genes than when discussing the fate of single major variants.

Isolating mechanisms, by which genetical diversity is preserved, are again given just prominence. The distinction is drawn between bars to crossing, which can arise by selective action, and hybrid incapacity, which cannot be ascribed to direct selection, and their inter-relations discussed. Hybrid breakdown receives, however, a fuller treatment than do bars to crossing, doubtless because of the greater wealth of experimental evidence about it, especially in animals. This is a matter of emphasis which time can be expected to change. The study of plants has much to offer here, as it has had in laying before us the variety of ways in which a species governs its own breeding structure and genetical composition—a matter on which a geneticist more directly concerned with plants would perhaps have laid rather greater stress.

Argument about emphasis must not, however, be allowed to obscure the value of Dobzhansky's book. The new edition will be as widely appreciated for the picture it sets before us of things as they are to be seen now, as its predecessor was for giving us the picture of 1941. "Genetics and the Origin of Species" has the rare merit of moving with the times—times which Prof. Dobzhansky has himself done so much to move; and it has the even rarer merit of changing not merely by accretion of the new but also by judicious shedding and condensation of the old; for, most remarkable of all, the third edition is in fact shorter than the second.

K. MATHER

HETEROCYCLIC COMPOUNDS

Six-Membered Heterocyclic Nitrogen Compounds with Four Condensed Rings

By C. F. H. Allen, in collaboration with D. M. Burness, Jean V. Crawford, F. W. Spangler, Eleanor R. Webster and C. V. Wilson. (The Chemistry of Heterocyclic Compounds, Vol. 2.) Pp. xiii+345. (New York and London: Interscience Publishers, Inc., 1951.) 10 dollars.

Thiophene and its Derivatives

By Howard D. Hartough; with Special Chapters by F. P. Hochgesang and F. F. Blicke. (The Chemistry of Heterocyclic Compounds, Vol. 3.) Pp. xvii+533. (New York and London: Interscience Publishers, Inc., 1952.) 16.50 dollars.

THESE two volumes are the second and third, respectively, of a series of monographs which are designed ultimately to cover the entire field of heterocyclic chemistry.

The contents of the second monograph of this series, "Six-Membered Heterocyclic Nitrogen Compounds with Four Condensed Rings", call for rather careful description. Regarding pyridine as aza-benzene, it will be appreciated that several poly-aza-benzenes are conceivable and, since the fusion of four benzene rings gives rise to seven distinct aromatic structures, the possible aza-analogues of these and of their hydroaromatic derivatives must be very numerous indeed. Relatively few are known, however, and in the present volume the number is further reduced by exclusion of benzacridine and benzophenazine types and of all compounds in which nitrogen as hetero-atom is shared between rings. Subject to these restrictions the compounds are classified and treated in the following order: aza- and poly-aza- derivatives of naphthacene, benz[*a*]-anthracene, benzo[*c*]phenanthrene, chrysene, triphenylene, benzanthrene and pyrene. Further subdivision is based on the number and position of the nitrogen atoms in the molecule, and sectional discussions are followed by descriptive lists of individual compounds, complete with references to the end of 1950. Nomenclature is treated in a rational manner, and, as is explained in the preface, an attempt is made through a comprehensive index to anticipate and cope with the difficulties of those who consult the volume on a particular quest.

The method of presentation is open to the criticism that it uses a canvas which is too large for the present-day picture. Apart from certain groups of dyestuffs and alkaloids of the chelidonine and aporphine types, there has been little systematic investigation and still less correlation among the known compounds of the class. None the less, it is the authors' achievement to have rescued this family of heterocycles from its interment in the journals or from, at best, the seclusion of dispersed and neglected paragraphs in major text-books. The volume is not only a record of existing knowledge but also, both explicitly and by implication, it points the need and marks a field for future research.

The monograph on "Thiophene and its Derivatives" presents, in fifteen chapters, a comprehensive account of these compounds, covering published work almost to the end of 1949. An additional chapter deals with selenophene and tellurophene analogues, but compounds containing condensed ring systems are reserved for a later volume. The earlier chapters contain such general topics as the history, occurrence and synthesis, together with the general physical and chemical properties, of thiophene and its homologues. A special chapter (contributed by F. F. Blicke) describes the toxicology and pharmacology of the compounds. Another special chapter (by F. P. Hochgesang) presents an informed discussion of the molecular structure and spectroscopy: it contains diagrams and tables relating to ultra-violet and infra-red absorption spectra, together with mass-spectral data, as obtained in the author's industrial laboratory. A helpful survey of factors affecting substitution in the thiophene nucleus precedes the systematic treatment of the various classes of thiophene derivatives, which occupies the major portion of the book. The treatment here is both authoritative and critical: it is kept within reasonable limits by the judicious use of tabulated information, all of which is fully documented. Each chapter is provided with an appropriate set of footnote references, and, in an appendix, laboratory preparations are given for some thirty representative thiophene derivatives. An efficient index completes the volume, which will undoubtedly become a standard work of reference for thiophene chemistry and, in its early chapters at least, will amply repay the attention of the general reader of chemistry.

QUANTUM MECHANICS OF VALENCE

Valence

By Prof. C. A. Coulson. Pp. x+338. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 25*s*. net.

DURING the past twenty-five years the application of quantum mechanics to the problem of the structure of molecules has led to great clarification of the chemical concept of valence. Prof. C. A. Coulson, who has made important contributions to the subject, has pointed out that every chemist should have an understanding of the quantum mechanical theory of valence, and he has written a book, as a supplement to the text-books of chemistry, to provide a basis for this understanding.

Chemistry is a large subject; and quantum mechanics, even the parts of quantum mechanics that relate to chemistry, is also a large subject, and quite different in general character. The problem of presenting quantum mechanics in relation to chemistry in a short book in such a way as to be helpful rather than confusing to the student is a difficult one. Coulson has attempted to solve it by giving sketchy accounts both of the mathematical methods of quantum mechanics and of the facts of structural chemistry. In his book the empirical system (the chemical system) of valence and molecular structure is discussed only briefly. The quantum mechanical system, however, is also presented rather briefly and superficially. It is my opinion that a student (the author says in the preface that the book is intended for chemical students) needs to build up a solid and complete framework of one sort or another, without gaps. Although the author states that practically no mathematics is needed for his purpose, the book contains many quantum mechanical equations, some of which are obtained from earlier equations in the book by methods that are not presented to the reader. This treatment—which might be called

descriptive quantum mechanics, as opposed to theoretical quantum mechanics—may be suited to some readers, but I fear that many would be confused by it.

Both the valence-bond method and the molecular orbital method are used in the discussion of the structure of covalent compounds. The author has allowed his enthusiasm for the molecular orbital method to lead him to make some statements that probably cannot be supported. Thus, after presenting a molecular orbital treatment of the carbon monoxide molecule, he says that the description of this molecule as resonating among three valence-bond structures is far less satisfactory. However, the molecular orbital treatment that he presents involves a serious error; the assumption is made that the oxygen atom uses a $2s$ orbital for an unshared pair, and a $2p_x$ orbital for the σ bond, but that the carbon atom uses hybrid bond orbitals $\frac{1}{\sqrt{2}}(s + p_x)$ and $\frac{1}{\sqrt{2}}(s - p_x)$ for its unshared pair and σ bond, respectively. The consideration of the energy of promotion of an electron from the $2s$ orbital to the $2p$ orbital shows that, in fact, the unshared pair for each atom occupies a hybrid orbital that is predominantly $2s$ in character, with a small contribution of $2p_x$, whereas the σ bond orbital is largely $2p_x$ in character, with a small contribution of $2s$. The same error, resulting from neglect of the $s-p$ promotion energy, occurs in the discussion of hydrogen chloride: the author describes the orbital for the σ bond and the orbital for the σ unshared pair of the chlorine atom as involving equal amounts of $3s$ and $3p_x$ character, whereas, in fact, minimizing the energy with consideration of the $s-p$ separation shows that the σ bond orbital is predominantly $3p_x$, with only about 2 per cent of $3s$ character, and that the unshared-pair orbital is predominantly $3s$, with only about 2 per cent of $3p_x$ character.

In twenty-five years the quantum mechanical theory of valence has become an important part of chemistry. It is still undergoing change, as a result of the efforts of Prof. Coulson and other workers in the field; and we may hope that in another decade or two a satisfactory solution can be found of the problem of presenting the subject to the chemical student, a problem which Prof. Coulson has tackled in his book on valence.

LINUS PAULING

MODERN PLANT TAXONOMY

Stages in the Evolution of Plant Species

By Jens Clausen. Pp. ix+206. (Ithaca, N.Y.: Cornell University Press; London: Oxford University Press, 1951.) 22*s*. 6*d*. net.

TAXONOMISTS are, on the whole, conservative, in the sense that they are cautious in introducing what may be far-reaching changes in their methods. There are two valid reasons for such caution. First, changes in classification affect not only taxonomists themselves, but also, since taxonomy is basic to all other branches of biology, changes in taxonomic concept or even nomenclature have repercussions over a wide field. Secondly, the taxonomist knows from experience that data as supplied by geneticists, cytologists, ecologists and other progressive modernists are sometimes inaccurate, and he may prefer to wait until they have been several times checked before incorporating them in his schemes as characters of taxonomic value. Nevertheless, most taxonomists acknowledge that much improvement in classification can result from a consideration and incorporation of evidence derived from experimental studies, cytological investigations, the analyses of large wild populations, and detailed researches into ranges and distributions. Doubts, however, are at times expressed whether such data from new lines of investigation can be satisfactorily combined with the morphological characters on which orthodox taxonomy is largely based. In other words, it is questioned whether a general classification utilizing all ascertainable characters can be prepared, or whether the theoretically possible limit is a number of special classifications. This most interesting book now under review strongly favours the view that a synthetic classification can be prepared, at least for taxa up to the size of genera.

Dr. Jens Clausen, in co-operation with Dr. D. D. Keck and Dr. W. H. Hiesey, has carried out a large series of comparative researches, involving field studies, transplant experiments, crossings and selfings, cytology, and taxonomy on a number of genera of the Californian flora. The results are summarized in a very attractive form in what are called eight essays that were given as lectures under the Messenger Foundation at Cornell University during November 1950. After an outline of the history of our concepts of speciation, Clausen logically deals in turn with local populations as the basic evolutionary unit, ecological races and morphological subspecies, interspecific barriers, the evolution of groups of species, and the physiologic-genetic species concept and the dynamics of the evolution of species and genera.

Clausen and his colleagues are fortunate in having almost ideal conditions for the kind of researches they have carried out and are continuing: the natural environments in California are varied; the native flora is a large one; the Carnegie Institution of Washington has wisely provided funds for the long-range researches; and three experimental stations at different altitudes have been established. That these and other advantages have been so fully used is to the credit of Dr. Clausen and those who have worked with him.

The half a dozen or so groups of species dealt with in some detail give a very varied picture of speciation. It is proved that this occurs in many ways, by steps of different sizes, over longer or shorter periods of time, and often irregularly. "We find species in all stages of differentiation. The most distinct ones, those that are the end products of the processes of speciation, differ in morphological characters, in ecological fitness to the environment, in the genetic systems by which they control this fitness, and in the homology of the chromosomes. The differentiating processes, however, do not always proceed simultaneously at the same rate along all the fronts mentioned. In ecological races of one species, physiological differentiation precedes the morphological and the genetic. In other cases morphological differentiation will be far ahead, and in still others, genetic separation begins even before physiological differences have enabled the forms to occupy different environments, or before morphological differences have provided satisfactory taxonomic labels for distinguishing the species. The most normal pattern of speciation, however, is a more or less simultaneous and gradual separation in morphologic, ecologic, genetic and cytologic characteristics." Again, "The

species exist in all stages of ecologic, genetic, cytologic, or morphologic distinctness, some preponderantly morphological, others preponderantly genetical, and still others preponderantly ecological".

The importance of genetical barriers between taxa is rightly emphasized, but it is explicitly stated (p. 158) that hybrid sterility or genetic incompatibility is not believed to be the sole criterion of specific distinctness. Examples quoted in several places in the body of the book show that it is not invariably an essential criterion. Isolating mechanisms are of many kinds, and every one has numerous variants.

One criticism may be made. I doubt if the statements regarding clines (p. 28) are valid. It is there said, "The term cline can be used only for individual characters, and not for an assemblage of characters of groups of individuals such as a series of populations, for a single individual may with respect to one character belong to one cline and with respect to another character to a different cline. Clines are therefore not commensurable with natural entities, and are oversimplified abstractions dealing with the variation of individual characters". There is, however, sometimes found to be a high correlation of character variations as the individuals of a cline are scored in a given direction.

Every taxonomist and every botanist, whether a taxonomist or not, is urged to read and consider this book. Very many portions could be quoted from it as proof of the truth of the final paragraph: "Even though we may think we dimly see some of the organization in the intricate network that connects the life of today with that of the past, we still do not know what enables living things to develop as they do, or how they first came into being. The research of the present century has merely opened our eyes to see a remarkable and still quite incomprehensible organization of living things. Faced with such a situation, the scientist becomes humble, for at this point he meets the Great Unknown".

W. B. Turrill

THE STONE AGE IN EASTERN PALESTINE

Le paléolithique et le mésolithique du Désert de Judée

Par René Neuville. (Archives de l'Institut de Paléontologie humaine, Mémoire 24.) Pp. 270+20 plates. (Paris: Masson et Cie., 1951.) n.p.

THIS is an important work which gives new information on the prehistory of a hitherto little-known region. The area of exploration lies to the south-east of Jerusalem in semi-desert calcareous country stretching eastwards to the Dead Sea. A number of cave and rock-shelter sites have been excavated and rich flint material unearthed. Culturally speaking, the industries found range from Tayacian and late Acheulean through Mousterian (in one instance, of the Kurdistan variety) to a late Palæolithic and Mesolithic (Natufian). In at least one site this last-named passes upwards into a Tahunian, which recalls the industry of the lower levels at Jericho. The Stone Age folk must have occupied many of the sites for long periods of time. Their industries show steady evolution; for example, there are no less than three Natufian levels with development from the early level to the latest. Important is the proof that the Tayacian culture must have existed side by side with the later Acheulean. These two cultures belong to two distinct culture groups, and their co-existence at the same time in this part of Palestine is interesting.

But the author and his collaborators have not been satisfied merely to dig the sites and then to publish accounts of the industries and fauna recovered. Their main interest has been to place the cultures in their geological and climatic settings. A succession of pluvial and interpluvial periods can be demonstrated, roughly coincident with the glacial and interglacial ones of more northern latitudes. There must obviously have been much wetter periods in this region in the past than nowadays, as to-day the country is only able to carry a very small population. Into the framework thus arrived at it has been possible to fit the successive cultures and to compare the results with what is known in other parts of the world.

The volume opens with a general description of the area, and this is followed by an account of the various sites excavated and a description of the finds unearthed. There are plenty of line drawings, both of the implements and of the fauna, and also twenty plates which supply further illustrations. No works of art were encountered except in two cases in Natufian levels where sculptures were discovered. This accords with Prof. Garrod's work at Mount Carmel, where, too, sculpture was encountered in Natufian levels. There is no doubt of the importance of this work to all students of the Stone Age in this part of the world.

M. C. Burkitt

CHEMISTRY IN THE INDUSTRIAL REVOLUTION

The Chemical Revolution

A Contribution to Social Technology. By Dr. Archibald Clow and Nan L. Clow. Pp. xvi+680+110 plates. (London: Batchworth Press, Ltd., 1952.) 50*s*. net.

WHEN a reviewer sees what by present-day standards is a large and well-produced volume entitled "The Chemical Revolution", he has visions of a historical account of the way in which chemical discoveries and their technological and commercial applications have revolutionized man's way of life, how they have brought him new sources of wealth, of health, richness of life, new possibilities of professional employment and new techniques of construction.

In the present volume the authors have limited themselves both in time and space in their treatment of the enormous field suggested by their title. Even so, it is quite impossible to deal adequately in this short notice with so important a work. The book treats of the chemical industry as an important concomitant of the Industrial Revolution until about the middle of the nineteenth century.

It was said of the study of acoustics, by Clerk Maxwell, that whole armies of musical scientists and of scientific musicians had fallen into that Serbonian bog without in any way filling it up. In a similar way, the scientific historians, economists and 'historical' scientists who will be required to deal with the subject under review will be legion.

The authors modestly say that they have said the first word on the subject and not the last. In the limitations which they have set themselves they have achieved a remarkable synthesis from the almost unexplored ground common to economic history and chemical technology. In manuscript the work was awarded the Senior Hume–Brown Prize by the University of Edinburgh; and, if the book is mainly devoted to the work of industrial scientists of North Britain, we can concede with the authors that "a galaxy of Scotsmen gave scientific direction to the Industrial Revolution, particularly in its hitherto neglected non-mechanical aspects". The writers have found inspiration in Lewis Mumford's "Technics and Civilisation" and have adopted his terminology, extended from that of Patrick Geddes—"one can divide the development of the machine and the machine civilization into three successive but overlapping and interpenetrating phases: eotechnic, palæotechnic and neotechnic. Speaking in terms of power and characteristic materials, the eotechnic phase is a water and wood complex, the palæotechnic phase is a coal and iron complex and the neotechnic phase is an electricity and alloy complex". The authors do not go beyond the first two phases.

The chief subjects in the book are minerals and manufacturing processes, the economy of common salt, ashes and kelp, the palæotechnic transition and vitriol in the Industrial Revolution. The chemical industry is the most polygamous of all industries, and Justus Liebig's famous *bon mot* of 1843, "We may fairly judge of the commercial prosperity of a country from the amount of sulphuric acid which it consumes", comes with even more point to-day. There are sections on balloons, bleaching and dyeing (before the days of Perkin), calico printing, mordants and mackintoshes. The considerable quantity of ammonia which was required for some of these processes was obtained from urine (a common practice being the dilution of this personally produced product by the canny Scots, until the use of a specially designed hydrometer put a stop to this 'minor racket'). The glass, iron, gas and tar, agricultural fermentation, the sugar and food industries are all dealt with by the historical–economic–sociological method. There is a useful chemical chronology from 1610 until 1856, and a glossary of dead chemical language, though some of the terms are still very much alive.

The book is a model of scholarly presentation, and it is fully documented and indexed. It is a handsome volume with 110 plates, including a reproduction of a coloured print of the old iron-works at Coalbrook Dale and a number of diagrams; and it is a pity that present-day costs necessitate a price of fifty shillings for the work.

W. L. SUMNER

THE FILM IN EDUCATION

The Film in Education

By Dr. Andrew Buchanan. Pp. 256+25 plates. (London: Phoenix House, Ltd., 1951.) 25*s*. net.

EVERYONE agrees that films can and should play an important part in education. Yet practice and realization fall far below theory and ideal: progress has been slow. The reasons for this sorry state of affairs form a complex network. For example, there is a lack of the research which would guide both producers and users: we do not fully know how people look at pictures or diagrams, how they gather information from them, what features are truly significant. There are economic obstacles: visual material is expensive to produce, the market is small, the risks of failure great. Perhaps more important than such difficulties is the persisting traditionalism of teachers accustomed to rely on the written or spoken word, desensitized by their training to the appeal and meaning of visual presentations, uncertain of the best ways of using films in teaching, uninformed regarding sources of visual material, timid in their use of projection apparatus.

Dr. Andrew Buchanan has long been known as a producer of outstanding educational films, and he has done much to popularize their use in schools and universities. He has drawn on his experience to produce a book which will certainly become a standard work of reference. It should be noted, however, that he has imposed restrictions upon himself and that his book is far from being a comprehensive treatise on visual education. He makes little mention of film-strip, wall-chart, printed pictures, etc., nor does he deal with methods of displaying visualizations other than optical projection. There is very little fundamental discussion and few references to psychological or research data. In a word, the title well describes the book—but this particular restriction of necessity impoverishes the treatment.

Dr. Buchanan begins by speaking of the purposes, advantages and limitations of educational films, and goes on to the use of films for specialized purposes in medicine, science and art. He describes the development of such films in many countries and considers the contribution of Unesco. He devotes chapters to a detailed description of the planning, production and distribution of visual aids, taking account of the increasing part taken by the National Committee for Visual Aids. These chapters are of real value since this kind of information is essential to teachers who desire to collaborate fruitfully with professional producers. The author goes on to give advice on the method of handling projectors and suggests ways of conducting discussions with classes who have watched films, so that they may really learn from them. In addition to all this, he has gathered valuable material regarding the effects on children of watching entertainment films, and regarding the views currently held by teachers on the films they would like to have.

One of the most interesting sections of the book is that in which Dr. Buchanan shows with figures that it is almost impossible to produce films for the small British market without incurring a loss, and that the British tradition of parsimony in educational administration militates against success. It appears that the establishment of the semi-official Foundation for Visual Aids has made the situation still worse by loading the scales still more against the producers.

Schools are by nature slow to change their ways or to adapt their practices to new conditions. Teachers are far less willing to adopt and employ new equipment or instruments than are workers in factories or offices; and, as was said earlier, our administrators have never learnt the lesson that education can be cheap or efficient but not both. In spite of all this, visual education has come to stay, and it will gradually affect practice and transform the process of instruction. Dr. Buchanan's book is a genuine contribution to the enlightenment of educators, and it may be warmly recommended to the attention of all who intend either to make or to use film.

THE ETHICAL DILEMMA OF SCIENCE

By Prof. A. V. HILL, C.H., O.B.E., F.R.S.
President of the British Association

EXACTLY a hundred years ago the British Association met for the first time in Belfast; and this year the Association is indeed happy to gather together in this city, to test its hospitality again and celebrate with it a century of progress of British science. In 1660 the little town of Killyleagh, some twenty miles from Belfast, was the birthplace of Hans Sloane, botanist, collector, physician, and president of the Royal Society, on whose bequest to the nation the British Museum in London was founded: its two-hundredth anniversary will be celebrated next year. The following century produced Joseph Black, a pioneer in chemistry and the theory of heat, who was the son of a native of Belfast and educated there. In 1824, in this city was born William Thomson, Lord Kelvin, the famous physicist and inventor, his father, a native of Co. Down, being then a teacher of mathematics in the Royal Academical Institution, Belfast. Joseph Larmor, born in Co. Antrim in 1857, was taught at that school, and when he became Senior Wrangler at Cambridge in 1880, repeating the success of a schoolmate the year before, a torchlight procession was held in Belfast—to the bewilderment (as Eddington records) of the shy young mathematician. This city was the birthplace in 1866 of E. W. MacBride, the zoologist, also at the same school: those of us who remember him affectionately could never have imagined him coming from anywhere else. A dear friend of many of us, Joseph Barcroft, the physiologist, was born at Newry in 1872, and learnt what he knew of the things that really matter (as he truly said) sailing in Carlingford Lough. And among the living, Frederick Donnan, a native of Holywood, Co. Down, and a graduate of Queen's University, Belfast, whose imagination has fertilized both chemistry and biology, tells me that he took part in the British Association meeting in Belfast in 1902. Thus it goes on. British science owes much to the fertile and imaginative minds, the vigorous temperaments and the warm hearts of our kinsmen in Northern Ireland.

We can recall, too, that applied science is a partner in the great industries for which Belfast and Northern Ireland are famous: the city for shipbuilding, engineering and textiles; and the surrounding country for agriculture. In the report of the British Association for 1852 there is a description of the vortex water-wheel, an early form of turbine, in working use at a nearby mill: James Thomson, elder brother of Lord Kelvin and for many years professor of civil engineering at the then Queen's College, had patented a vortex water-wheel in 1850. In the same report is a long account, by the professor of agriculture at Queen's College, of the composition and economy of the flax plant; and thirty pages were devoted to the fattening of animals—English animals, it is true, but their cousins in Ireland have been apt pupils. In such practical arts, based alike on scientific knowledge and traditional skill, the contribution of Northern Ireland has been as distinguished as in the advancement of science itself; and it may confidently be expected that the present meeting of the British Association will serve not only to celebrate the achievements of the past century but also to foster the endeavours of the next.

The President for 1852 was Edward Sabine, astronomer, explorer and geodesist, a colonel then in the Royal Artillery. Sabine at that time was treasurer of the Royal Society, and at various others he was physical secretary, foreign secretary and president: indeed, for completeness, he should have been biological secretary too, for his name occurs in an index of British and Irish botanists, and in the British Museum are plants collected by him on Arctic expeditions. Sabine was an Irishman, and if the president this year is English, with an ancestor from Northern Ireland two hundred years ago, that only emphasizes, after a century, the unity of science. Indeed, there are many Irishmen at this year's meeting from the other side of the border: they are doubly welcome, for science admits no frontiers, and customs duty is not levied on ideas or friendship. Sabine's address referred particularly to the subject of his own chief interest for many years, the periodic variations of terrestrial magnetism: indeed, he announced in his address the discovery of the connexion between sunspots and magnetic disturbances in the earth. He finished his address by referring to "allusions . . . made by influential men . . . to a direct representation of Science in Parliament". The benefit, he said, which the legislature might derive from such a change was a question rather for statesmen than for scientists; but as regards science itself, he expressed his strong conviction that the possible gain would be far outweighed by inevitable loss, and that scientific men could not too highly value the advantage they possessed in the undisturbed enjoyment of their own pursuits untroubled by the excitements and distractions of political life. The practical importance of science to-day, and its impact on public affairs, have greatly reduced that undisturbed enjoyment; and though all would agree that the direct representation of science as such in the House of Commons is impracticable, none would doubt the advantage to Parliament and the nation if more of its members had some personal acquaintance with science. It might indeed be well, in a reformed Second Chamber, to provide the same representation to science as at present is afforded to the Church and the Law.

Two famous young Irishmen were present at the Belfast meeting of 1852. William Thomson, Lord Kelvin, elected to the chair of natural philosophy at Glasgow six years earlier at the unusual age of twenty-two, was president of the Section of Physics: the other, George Gabriel Stokes, then thirty-three, delivered a public lecture on fluorescence due to ultra-violet light passing through a solution of quinine. Both were among the foremost physicists of the following half-century, and Kelvin succeeded Stokes as president of the Royal Society.

The next meeting in Belfast was in 1874, when another Irishman, John Tyndall, presided. His notable address will be referred to later. Huxley delivered an evening discourse with the provocative title, "The Hypothesis that Animals are Automata"; whether for that or for some other cause, it is recorded that he was threatened with assault by a nonconformist minister. On the lighter side, a description was given of an old lady of 111 who chatted away

continually in a clear voice, was in possession of all her faculties, took snuff, and had white hair and a skin as soft as velvet—which is encouraging to those who take snuff and have white hair.

The last meeting at Belfast was fifty years ago, in 1902, under the presidency of James Dewar, a Scotsman, famous for his work on the liquefaction of gases. Lord Kelvin, loyal to Belfast, read a curious paper in the Physics Section entitled "Animal Thermostat". The great physicist, arguing on thermodynamic principles, speculated whether the breath of an animal, kept a considerable time in a hot bath above the natural temperature of its body, might be found to contain no carbon dioxide at all; possibly even a surplus of oxygen, pointing to an 'unburning' of matter in the body. I hope the physiologists were present at the discussion; one of them, Joseph Barcroft, would certainly have offered to make the experiment on himself. Henry Armstrong, provocative as usual and at considerable length, gave a presidential address to the Section of Educational Science.

It is a very special pleasure to be called to the presidency of the Association in succession to H.R.H. the Duke of Edinburgh, who won the confidence and esteem of scientific people at the meeting last summer, confirmed by many contacts with them since in Canada and the United States and recently in Britain. He presided at the December meeting of the Council, and we told him then how glad we were that these contacts were soon to be extended to Ceylon, Australia and New Zealand. Those hopes, alas, have had to be deferred; and on behalf of the Association I wrote in February to tell him of our deep sympathy in the bereavement which H.M. The Queen and he had suffered. We mourned the loss, not only of a Royal Patron but of one whom all regarded with personal gratitude and affection. I added, and I know you will warmly confirm, that our sorrow and sympathy were accompanied, since we had seen him at work with us, by the certain expectation that the same confident affection will support the Queen and him in the years ahead.

The Duke of Edinburgh concluded his presidential address last year with the words: "It is clearly our duty as citizens to see that science is used for the benefit of mankind. For, of what use is science if man does not survive?" Here was a challenge to his successor: to discuss how far science has already contributed to human betterment, how far it has provided fresh problems, dangers and difficulties; and to suggest ways in which all who are concerned with science can help, as citizens, to make sure that its results in fact are beneficial.

"As citizens"—for scientists, as such, have no title to superior wisdom or virtue, and outside their special knowledge they are just as likely as others to be misled. The fundamental principle of scientific work is unbending integrity of thought, following the evidence of fact wherever it may lead, within the limits of experimental error and honest mistake. On this there can be no compromise; and since science is a universal interest of mankind, recognizing no barriers of race, class, religion or opinion (provided that is honest), a necessary condition of its advance and application is one of friendliness, frankness and equality. Goodwill and integrity, therefore, are indispensable alike to scientific progress itself and its successful employment for the benefit of mankind. Those who look to scientists as magicians, able to conjure a universal formula out of a hat, may be disappointed to find only so ancient a doctrine: and admittedly, there *is* far more to science than integrity and goodwill. But these are the qualities chiefly required to utilize the opportunities, to resolve the problems and difficulties, which science has provided for present-day society.

The common phrase, "this scientific age", is all too apt to imply, with little justification, that the majority of people, at least in highly developed countries, now think and act scientifically; and, with no justification at all, to suggest that science can replace the older motives of human conduct. It is true that the external circumstances of life have been vastly altered by the applications of scientific discovery and invention, though as yet for only a minority of mankind. The future alone can decide whether natural resources and human ingenuity will prove sufficient, given statesmanship and goodwill, for the same transformation gradually to affect the whole of human society. If not, are stable conditions ultimately possible? Or will there be perpetual conflict between the 'haves' and the 'have-nots'? It is true also that the methods, ideas and results of scientific inquiry have penetrated widely, if not deeply, into popular thinking and belief: the jargon at least of science is widespread, and magic and superstition are gradually losing, if not their currency at least their respectability. Yet such changes may have little real influence on the basic pattern of human behaviour, and, if witches are no longer hunted down and killed, political and racial intolerance can lead to even wilder and crueller excesses. In clearing away old idolatries there is always a danger of allowing new ones to creep in: the unclean spirit went out when the house was swept and garnished, but only to return with seven others more wicked than himself. The improvement of man's estate by the application of scientific knowledge is one of the loftiest of adventures; but a belief that it can be achieved by scientific methods alone, without a moral basis to society, is a perilous illusion. If the methods of human experiment and racial improvement adopted by the Nazis could be regarded purely as applied biology there might be much to say for them. But most of us believe that by abandoning a faith (which has nothing directly to do with science) in the sanctity of the human individual and of moral law they were heading straight for disaster. Yet we shall see later the dilemma in which such scruples put us, in respect of the gravest of all world problems.

The conflict between new knowledge and traditional belief is no novelty. When Eve saw that the Tree of Knowledge was good for food and that it was pleasant to the eyes, and to be desired to make one wise, she took of the fruit thereof and did eat and gave also to Adam and he did eat. This led to their exclusion from the Garden and the warning "in sorrow shalt thou eat of it all the days of thy life". Again and again the attempt has been made to forbid the fruit of scientific knowledge. In 1874 in Belfast, John Tyndall delivered a presidential address to the British Association which provoked a hurricane of controversy: the records tell us that it was denounced from every pulpit in the city. Yet, reading it now, one is impressed not only by its courage but also by its reasonableness. It is true that he claimed that science will wrest from theology the entire domain of cosmological theory, whether of living or of non-living things; but he had previously referred to the immovable basis of the religious sentiment in human

nature, bringing as he said "completeness and dignity to man". The views of Lucretius and Bruno, Darwin and Spencer, might be wrong: whether right or wrong, he insisted, we claim the right to discuss them. If to-day I claim the right to discuss not only the scientific facts themselves but also their consequences in human affairs I doubt whether denunciation will follow: if it does, I shall be sorry but unrepentant.

The development which has brought most vividly to the public conscience to-day the ethical problems aroused by the advance of scientific knowledge lies in the field of nuclear physics; and groups of scientific people in the free countries of the world are vigorously debating its various consequences, among them particularly the secrecy attached to weapons as new and devastating as those provided by nuclear fission. Atomic physics, however, is only one of many scientific developments which have brought, or are bringing, a mixture of possible good and evil about which judgments of relative value must be formed; we must not get too excited about one of them. There is no secrecy about most of these developments—they occur gradually and continuously before our eyes, and we tend to accept them without question as though they were natural phenomena; yet, in fact, the consequences of one of them provide the most solemn problem in the world. The dilemma is this. All the impulses of decent humanity, all the dictates of religion and all the traditions of medicine insist that suffering should be relieved, curable disease cured, preventable disease prevented. The obligation is regarded as unconditional: it is not permitted to argue that the suffering is due to folly, that the children are not wanted, that the patient's family would be happier if he died. All that may be so; but to accept it as a guide to action would lead to a degradation of standards of humanity by which civilization would be permanently and indefinitely poorer. Conduct usually falls short of principles; but that would be the worst reason for abandoning principles altogether.

In many parts of the world advances in public health, improved sanitation, the avoidance of epidemics, the fighting of insect-borne disease, the lowering of infantile death-rates and a prolongation of the span of life have led to a vast increase of population. Not only is the population increasing, but also in many places its rate of increase is still rising; and these processes will take so long to reverse that for many years to come the shortage of natural resources, particularly of food, is bound to provide increasing deprivation and disturbance. That provides the practical motive of the Colombo Plan. In India, a Government Planning Commission, in a report of July 1951 entitled "The First Five Year Plan", has dared to face the facts. A doubling in the past thirty years of the survival-rate (births minus deaths) has led to a rate of increase of nearly 1½ per cent a year, a total of 5 million every year in a population of 360 million.

"With all the effort that the First Five Year Plan will represent, it will be possible barely to restore by 1955–1956 the pre-war standards in regard to food and clothing. Increasing pressure of population on natural resources retards economic progress and limits seriously the rate of extension of social services so essential to civilized existence."

The pre-war standard, in fact, was very poor; much of the population existed below the level of a decent life, scores of millions only just above that of famine. Yet the gigantic national effort proposed in the Five Year Plan, even if successful, may only just restore that miserable standard. Can it sustain it then if the rate of population increase continues? It is easy to answer that a higher standard of life has led in other countries to a gradually falling birth-rate; but a higher standard requires a far greater charge on natural resources of all kinds, which cannot be met until the pressure of population is reduced.

In the meantime there is more than danger that the emergency will result in an over-use of natural resources, leading by land erosion, deforestation and other factors to permanent and irretrievable loss; this has happened already, and is visibly happening now, in many parts of the world. In a special section on "Family Planning" the Indian report recognizes that "an alteration in population trends takes at least a few generations to materialize"; and steps are suggested for the education of public opinion on the need for limitation, and for experimental efforts to be made in the application of simple methods of birth control. For its wisdom and courage in acknowledging the gravity of the situation the Indian Planning Commission deserves every support; but the problem itself has not begun to be solved, and its consequences will dominate the development of India for many years. Indeed, its gravity will continue to increase. Malaria is admitted by the Planning Commission to take an annual toll of a million lives, and tuberculosis of half a million. The resolute use of insecticides and anti-malarial drugs could soon reduce the former to a small fraction; tuberculosis is bound to require more effort and a longer term. Nobody would dare to say that steps to combat these diseases, and others such as cholera, to improve rural and industrial health, to increase the supply of drugs and medical equipment and services, should not be taken on the highest priority: but the consequence must be faced that a further increase of a million people a year would result. Thus science, biological, medical, chemical and engineering, applied for motives of decent humanity entirely beyond reproach, with no objectionable secrecy, has led to a problem of the utmost public gravity which will require all the resources of science, humanity and statesmanship for its solution.

The example of India has been taken because of the sheer magnitude of the problem and because its seriousness is now admitted by humane and responsible men; but the same conditions exist already in many parts of the world and will soon exist elsewhere. It is *not* a question only of food; if a higher standard of life is to become universal, with education, communications, housing, reasonable amenities and public health, a far greater demand will be made on all such natural resources as power, chemicals, minerals, metals, water and wood. One is left wondering how long these can possibly take the strain. Could world supplies conceivably hold out if the present requirement per head, in the United States, were multiplied in proportion to meet the same demand everywhere—even without any increase of present population; and if so, for how long? There is much discussion of human rights. At what level can these be reasonably pitched? And do they extend to unlimited reproduction, with a consequent obligation falling on those more careful? These problems must be faced not only with goodwill and humanity but also with integrity and courage, not refusing to recognize the compulsion of simple arithmetic. It is right that the scientific imagination should be allowed to play sometimes with the more distant future,

when possibly new methods and resources may be found to solve all problems; but only on condition that our minds are not deflected from the urgent realities of the present.

By vast improvements in communications, which have made the world so small, applied science has been one of the chief agents in the present ferment of social, political and economic thought. Can one urge, after the event, that the application was a mistake and that the majority of mankind could better have remained isolated and in ignorance? By making world war technically possible, applied science has helped to stir up national ambitions and social revolutions which, if poverty and deficiency continue without hope, may lead to major world catastrophe. Should we therefore refuse to employ science in defence of liberty and resign ourselves to a universal police state where no scruples are permitted? Are we, in scientific research, to say that some subjects may be investigated, but not others for fear of the consequences? Who then is to decide and by what international authority? And is it practical to insist that all scientific knowledge should be fully and openly disclosed, without secrecy or reservation of any kind, military or industrial? These are problems which cannot be solved by rhetoric, or by any simple formula. The purpose of setting them out is to make clear that we must face them with honesty and courage; for they will not solve themselves.

I have led you to the ethical dilemma which perplexes many of us by taking an example in which few would question either the motives of those who made the original discoveries, or the humanity of their application; or indeed could wish that the fruit of the Tree of Knowledge had been left untried. It is easy to say now that, side by side with the control of disease, there should have been an equal and parallel effort in education, particularly the education of women as responsible citizens; for there is no possibility, if women remain ignorant and illiterate, of intelligent widespread family planning and control. But education alone would not have been enough, or indeed possible itself, without a substantial measure of material and social betterment; and the expense and effort involved in this would have been indefinitely greater than in the application of medicine and hygiene, which after all has been relatively cheap. Had it been possible to foresee the enormous success of this application, would humane people have agreed that it could better have been held back, to keep in step with other parallel progress, so that development could be planned and orderly? Some might say yes, taking the purely biological view that if men will breed like rabbits they must be allowed to die like rabbits, until gradually improving education and the demand for a higher standard of life teach them better. Most people would still say no. But suppose it were certain now that the pressure of increasing population, uncontrolled by disease, would lead not only to widespread exhaustion of the soil and of other capital resources but also to continuing and increasing international tension and disorder, making it hard for civilization itself to survive: Would the majority of humane and reasonable people then change their minds? If ethical principles deny our right to do evil in order that good may come, are we justified in doing good when the foreseeable consequence is evil?

I remember asking an eminent Indian who had taken part in drawing up the so-called Bombay Plan of 1944 why there was no mention of the gravest problem of all, overgrowing population; he replied that his colleagues and he had indeed discussed it, but had decided to leave it to God. To a biologist aware of the methods by which animal population is in fact controlled by Nature, this seemed pretty poor comfort; yet there are many who really take that view, admittedly with the element of reason that we never can be sure that things may not turn up to make all our calculations wrong. Should we then just continue to do the good we see in front of us, in confidence that if our motives are humane, good and not evil will finally result? Or, taking that rather easy course, are we not showing a lack of the fundamental virtues of courage and integrity?

The dilemma is a real one, and cannot be resolved by any simple expedient. In another form it is perplexing many of those who are concerned with the development of nuclear physics, the ultimate service of which may be very great, possibly essential if our present type of civilization is to continue when other sources of power dry up; while the benefits to medicine and industry are already substantial. *But*—nuclear fission has released the threat of unprecedented violence, with the possible destruction of many millions of lives and the accumulated treasures, moral and material, of civilization. The individual conscience may tell a man to have no part in it: that is easy enough, for there are plenty of other interesting things to do, but it does not solve the problem. Moreover, it is possible that defensive weapons, based on nuclear fission, but not of the type intended for mass destruction, can be developed which would make armed aggression intolerably costly. What then of the abolition of secrecy? In principle, yes, for the historic and unique contribution of science to international goodwill has been in sharing knowledge regardless of race and frontier, and the chief satisfaction of scientific work, the condition of its fruitful development, is frank and free discussion. "Cast thy bread upon the waters, for thou shalt find it after many days" is wise and acceptable counsel in dealing with scientific knowledge; while "he that observeth the wind shall not sow and he that regardeth the clouds shall not reap" is as aptly applied to human relations as to agriculture. Every possible endeavour, therefore, should be made towards international agreement on sharing scientific and technical knowledge and controlling nuclear weapons; but this, like peace itself, is a concern of every citizen, not only of scientific people. It is hard enough to get international agreement in quite simple matters, such as the perilous state of the north European fisheries, where no secrecy is involved and little national prestige, and the scientific evidence is unequivocal; but we must go on trying.

Much scientific and technical advance has led to unexpected dangers and difficulties. Without our present knowledge of bacteriology and preventive medicine, gigantic armies could never be kept in the field, and land war on the recent scale would be impossible. Is medical science, therefore, to be blamed for twentieth-century war? The indiscriminate use of insecticides, by upsetting the balance of Nature, can quickly do more harm than good. Radio communication may be used for spreading lies and disorder as well as truth and goodwill. Developments in microbiology, in many ways beneficent, may be used in the future for biological warfare, with effects at present unpredictable; and control by international agreement and inspection might be very difficult. The list need not be multiplied, for all are aware that every new benefit to

mankind provides also its own dangers, either as unexpected consequences or by deliberate misuse. Science is not alone in this: liberty may lead to licence, religion can be used to inflame passions, and laws can be exploited to protect wrongdoing. If men of science feel called upon to examine their consciences, so much the better; but they need not imagine that in this they are exceptional.

It has been debated whether "the scientific mind is fundamentally amoral". The real answer is that there is no such a thing as "*the* scientific mind". Scientists, for the most part, are quite ordinary folk. In their particular scientific jobs they have developed a habit of critical examination, but this does not save them from wishful thinking in ordinary affairs, or sometimes even from misrepresentation and falsehood when their emotions or prejudices are strongly enough moved. Their minds are no more amoral than those of surgeons, lawyers, or scholars. As investigators, most of them realize that their function would be stultified were they to introduce moral data into a scientific argument. A surgeon is not required, or indeed allowed, to consider whether it would be better for the world if his patient died under the operation; he has only to carry it out with skill, care and integrity. But it would be foolish to conclude that the surgical mind is amoral. The surgeon himself, as a human being, has to make moral judgments, but he does so outside the operating theatre. So it is with scientific people; like all good citizens they must take account of ethical considerations, and the chief of these, as with other good citizens, are of integrity, courage and goodwill. Integrity forbids them to allow feelings of any kind to obscure facts, but that does not make them amoral; after all, integrity is the first condition of morality.

In the practical world of to-day, complete abandonment of secrecy, in government and industry, is out of the question. The advantages to international relations, and to general scientific progress, of the greatest possible freedom are evident; to these can be added the impossibility, in a free democracy, of keeping the best people unless the conditions of their work are congenial. If scientific men consistently avoid jobs which seem to them to fall short of reasonable freedom, they will force changes of organization so that only necessary secrecy is maintained. The penalty of filling an organization, governmental or industrial, with second-rate people, cheerfully amenable to unnecessary restrictions, is far too evident in its result on efficiency to be tolerable for long. The cure, therefore, is largely in scientists' own hands. In this, as in many other aspects of their work, moral considerations come in, and the only way to resolve the dilemma which is in so many minds is to discuss it frankly. To neglect it altogether is not amoral but immoral; it is the duty of all of us as citizens to consider the ethical basis of our work.

To-day, when the public importance of science and its popular esteem may turn some people's heads, it is well that scientists should realize that the prestige of science is not their personal property, but a trust which they have an obligation to pass on uncompromised to their successors. The popularizing of genuine science is an important public service, and we should all be ready to take our part in it according to our powers; but to use the general prestige of science as a bait to attract attention to pronouncements on other topics, for example, on politics or religion, is a disservice both to science and the public. As a citizen I need no more justification than any other citizen in saying what I like about such things; but I have no right to pose as a representative of science in discussing them. In the days when the representatives of religion claimed supernatural knowledge of the natural world, it was necessary to insist, as Tyndall did, that the natural world belongs to science. Fortunately those days are past. If they now claim that the facts and trends of over-population are not what we say, we can argue about that as a scientific question: but if they insist that its consequences should be left to God, they must allow us as citizens to take the opposite view. If political pressure were applied in any way to force conformity to particular scientific theories, as happened in Germany and is happening now elsewhere, then one's right and indeed one's duty would be clear, alike as citizen and as scientist. But the nature of political institutions and the policies of political parties are not scientific questions, and how I choose to vote has nothing to do with science. Indeed, curious as it may seem, the spectrum of political opinion of scientists in Britain is much the same as that of other similar groups: though the loudspeakers are generally tuned in to one particular wave-band.

Some seventeen hundred years ago there crystallized out, from many centuries of experience of the human problems and ethical necessities of medicine, the so-called Hippocratic Oath. The obligation of integrity and trust; the insistent claim of suffering; the care of mothers and children; solicitude for the old and weak; the sanctity of human life: these are as vital a part of medical tradition as its science and its art. Practice, it is true, may lag behind principles, but at least such failure is regarded as discreditable; and it is hard to imagine any kind of civilization in which the ethical principles of medicine were generally disregarded. That is one reason why the future possibility of biological warfare is particularly repugnant. To-day science finds itself, unexpectedly and without those centuries of tradition and experience, in a position no less important to the community than medicine; and its ethical principles have not yet clearly emerged.

Every candidate for admission to the earliest of American learned associations was required to answer yes to the question: "Do you love truth for truth's sake, and will you endeavour impartially to find . . . it for yourself and communicate it to others?" That affirmation might have its place in a modern scientific version of the Hippocratic Oath. But again the same dilemma arises—"endeavour impartially . . . to communicate it to others". Apart altogether from considerations of national security, in many fields to-day much of the best research is done, and done increasingly, in industrial laboratories. Those who have seen and admired such work, and the people who do it, cannot but applaud the foresight which made it possible. But if all the results are to be communicated at once and impartially to others, could directors and shareholders be reasonably expected to continue their support? Indeed, if an industry were nationalized, could it afford to give away its secrets to competitors abroad? Not in any real world, in which a nation must remain solvent and industry must depend for success on the rapid application of new knowledge. The dilemma must be met by reasonable compromise, of which perhaps the most hopeful sign to-day is that many of the directors of industry come up through research departments. A friendly and familiar contact between management and research, and between industrial

and outside scientific workers, can reduce this particular dilemma to manageable size.

A graver problem is provided by research under government, when considerations of security come in. In the emergency which became evident in 1935, the secret development of radar for purposes of air defence aroused no obvious pangs of conscience; and many other developments come in that class. But the surest of military maxims is that counter-attack is an essential part of defence; to limit scientific methods to defensive weapons would be to ensure defeat, indeed it is quite impracticable. But let us be realists; so long as offensive weapons may be used, the part played by the scientist is no more immoral than that of the engineer, the workman, the soldier or the statesman, and the attitude of 'holier-than-thou' is unbecoming. We all bear, as citizens, an equal responsibility. But is it practical to suggest that all scientists in all countries should agree, and hold to their agreement whatever happens, to take no part in research on offensive weapons? Or at least should they endeavour impartially to communicate its results to others? The answer is evident. There are individuals in all free countries who find such work intolerable. In those countries their scruples are respected, and they are at liberty to do something else; but let them not imagine that the problem is solved that way, or that those who think otherwise are necessarily stupid or immoral. The first condition of freedom is freedom of conscience, and the scientist has the same right to that as any citizen: but freedom does not extend to giving away other people's property, whether of goods or knowledge.

There seems to be no simple answer to the riddle. All knowledge, not only that of the natural world, can be used for evil as well as good; and in all ages there continue to be people who think that its fruit should be forbidden. Does the future welfare, therefore, of mankind depend on a refusal of science and a more intensive study of the Sermon on the Mount? There are others who hold the contrary opinion, that more and more of science and its applications alone can bring prosperity and happiness to men. Both of these extreme views seem to me entirely wrong—though the second is the more perilous, as more likely to be commonly accepted. The so-called conflict between science and religion is usually about words, too often the words of their unbalanced advocates: the reality lies somewhere in between. "Completeness and dignity", to use Tyndall's phrase, are brought to man by three main channels: first by the religious sentiment and its embodiment in ethical principles, secondly by the influence of what is beautiful in nature, human personality or art, and thirdly by the pursuit of scientific truth and its resolute use in improving human life. Some suppose that religion and beauty are incompatible, and others that the æsthetic has no relation to the scientific sense; both seem to me just as mistaken as those who hold that the scientific and the religious spirit are necessarily opposed. Co-operation is required, not conflict: for science can be used to express and apply the principles of ethics, and those principles themselves can guide the behaviour of scientific men; while the appreciation of what is good and beautiful can provide to both a vision of encouragement.

Is there really, then, any special ethical dilemma which we scientific men, as distinct from other people, have to meet? I think not: unless it be to convince ourselves humbly that we are just like others in having moral issues to face. It is true that integrity of thought is the absolute condition of our work, and that judgments of value must never be allowed to deflect our judgments of fact. But in this we are not unique. It is true that scientific research has opened up the possibility of unprecedented good, or unlimited harm, for mankind; but the use that is made of it depends in the end on the moral judgments of the whole community of men. It is totally impossible now to reverse the process of discovery: it will certainly go on. To help to guide its use aright is not a scientific dilemma, but the honourable and compelling duty of a good citizen.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

CONTRIBUTORS TO EXPERIMENTAL PHYSICS FROM BRITAIN

PROF. A. M. TYNDALL'S presidential address to Section A (Mathematics and Physics) deals in the main with some contributions by workers in Great Britain to experimental physics. His selection of topics has been made to illustrate the citation of the recent award of the Nobel Prize to Prof. C. F. Powell, expressed in the following words: "His special claim to consideration is, in my view, the fact that he has shown that discoveries of fundamental importance can still be made with the simplest apparatus".

The reason for quoting from this occasion is that the words emphasize an approach to the field of experiment which is characteristic of much British physics and following the great scientific tradition of the nation. Examples are common in the literature of simple experiments which have opened up large fields for discovery. After giving examples from the work of Rayleigh, Boys and Chattock, Prof. Tyndall refers to simple experiments which have been fundamental to the development of the items of the main sectional programme of the meeting: the work of the Cavendish Laboratory in the days of 'sealing wax and string', which forms the root of the discussion this year on electrical discharge in gases; and the simple adaptation to radio of the principle of Lloyd's fringes, by which Appleton initiated not only the exploration of the ionosphere but the fields of radio-meteorology and radio-astronomy. Again, ever since Sorby first studied microscopically the surface of opaque solids, Great Britain has contributed widely to the study of their physical properties. A recent example is that of the theoretical work of Frank on the growth of crystals by condensation of atoms on the step of a screw dislocation, and its experimental confirmation by Griffin and others by photographs of crystal surfaces.

But the best modern example of the consequences of a simple idea comes from the field of nuclear physics. Though much has been written on Britain's past contributions to nuclear physics, less has been said of the fact that it still leads the world in the study of processes of the highest energy. This has followed from the simple device of exposing a photo-

graphic emulsion to cosmic rays, first at high mountain altitudes and later from balloons. This technique at Bristol, and cloud-chamber investigations from Manchester, have been responsible for the great majority of the important discoveries in nuclear processes of high energy since the Second World War. A number of new types of particle of short life have been discovered, all but one of them in Britain. By a study of their modes of decay, complexity is beginning to give way to order in the phenomena disclosed.

The great machines of the world, absorbing millions of pounds of money, are now studying under controlled conditions the properties of π-mesons discovered by tracks in a photographic emulsion exposed to cosmic rays at mountain altitude. Meanwhile, with the aid of balloons, particles of energy two thousand times greater than anything so far attainable in a laboratory are under observation. It is therefore important to regard this work as part of the larger programme, so that funds, relatively small in amount, continue to be available for its prosecution and extension.

THE ADVANCING FRONT OF CHEMISTRY

THE pace of scientific, social and economic changes in modern times is unprecedentedly rapid. Thus, as Prof. W. Wardlaw points out in his presidential address to Section B (Chemistry), it is easy to understand why the pace of the science of chemistry is growing ever faster and faster. In the past quarter of a century, the number of investigators in both pure and applied chemistry has increased enormously, while research itself is more adequately financed and to some extent better organized than ever before. It is tempting but not very profitable to try to imagine what will have been accomplished, say, fifty years hence, if this acceleration continues. Chemists may well consider that the pace of advance may be such that no human mind will be able to correlate into any significant whole the enormous accumulation of chemical facts. Yet man's curiosity about the universe and his own complex self will most probably increase, and the astonishing growth of the science of chemistry will continue. At intervals during the past half-century prophets have confidently predicted the demise of inorganic chemistry and even of organic chemistry. Chemistry, however, has confounded the prophets by its amazing vitality.

The award of the Nobel Prize for Chemistry for 1951 to McMillan and Seaborg directed the attention of the whole scientific world to the most spectacular advance made in chemistry for a long time: the extension of the Periodic System from element 92 (uranium) to element 98 (californium). Particularly important in this work was the development of ultramicrochemical methods of analysis, which enabled the chemistry of the trans-uranium elements, usually available in millionths of a gram, to be investigated. The combined discoveries of the physicist McMillan and the chemist Seaborg and their associates have opened whole new fields for the investigator interested in the realm of inorganic chemistry.

Chemistry already has made an indispensable contribution to atomic energy research and development, and chemists will fill a major role in establishing nuclear power as a benefit to humanity. The next phase in the development of atomic power probably depends more on new materials than on any discovery in nuclear physics or improvement in atomic technology. This extension of technological interest in new materials, all over the world, is bound to emphasize the need for broadening our knowledge of both the familiar and unfamiliar elements and compounds. It is surprising how little we know about many of the chemical elements, even the metals. We know still less about certain elements which lie midway between the metals and the non-metals, the so-called metalloids. A host of new researches has been set in motion primarily by the needs of the atomic energy programme. However, the results will be the starting-point of new developments in every phase of industry. In the United States, there is a great revival of interest in inorganic chemistry, and in Britain there are signs that its value and importance are being increasingly realized.

During the past decade, most people have had an uneasy feeling that all is not well with their food. As we all know, the food processor has chemicals for every need—preservatives, emulsifiers, colouring agents, etc. Some idea of the magnitude of this problem of chemicals in food can be obtained from the report of the Delaney Committee set up in June 1950 by the United States Congress. The Committee heard the striking evidence from the officers of the Food and Drug Administration that 704 extraneous substances were thought to be in use. Of these, only 428 were considered harmless as normally employed, leaving 276 of which the safety was open to question. There is little doubt that the wide publicity which this subject is receiving will call for planned administrative action in the United Kingdom.

GEOLOGICAL RESEARCH AND ITS APPLICATIONS

FOR his presidential address to Section C (Geology), Dr. J. E. Richey takes as his subject "Some Aspects of Geological Research and their Practical Application". Quoting a remark made by Henri Poincaré in "La Science et l'hypothèse" that "Science is built of facts, as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones is a house", Dr. Richey has selected a number of classic examples of geological research as illustrations of the methods employed in building the 'geological house'. The investigations chosen are mainly from Great Britain and range from those of James Hutton and William Smith to the present day. From an analysis of these and of the criteria used in each case, a definite pattern of evidence which led to the particular conclusion can be adduced. Dr. Richey sets out the various types of proof-pattern made use of under the following headings: anomalies in observed data; similarity and dissimilarity of occurrences; analogy; repetitive evidence; geometrical patterns of evidence; and intersection of different lines of evidence. Examples of each type of proof-pattern are given.

Dr. Richey then deals with practical applications of geology. It is especially emphasized that economic geology is not a subject apart from pure geology but is simply geology applied to a variety of objectives containing an economic purpose. Particular subdivisions considered are coalfield research, the search for oil, the location of ore deposits, and civil engineering problems. In each case one or more examples are given in illustration of the main patterns of evidence involved. These include the discovery of

the Kent Coalfield, the guiding idea of Godwin-Austen being based upon geometry on the grand scale; in oil geology, the use made of geometrical patterns exemplified by the anticline of Bahrein Island in the Persian Gulf, mapped by G. E. Pilgrim, and by the recently investigated dense fissured limestones of Venezuela, with a reference to the value of palæogeography in the search for new fields; in ore geology, again with geometrical patterns dominant in the varied types of fracture zones in American ore-fields, and the recent mineralogical research on the hydro-thermal 'plumbing system' of East Tintic in Utah by T. S. Lovering; in civil engineering, the location of the Vrynwy dam-site in North Wales which followed from the pursuit of a scientific idea by an engineer, Dr. G. F. Deacon, and the investigations by Prof. P. G. H. Boswell which preceded the driving of the Mersey vehicular tunnel at Liverpool, an example of the use of converging lines of evidence.

In conclusion, a few words are added concerning the investigator himself, the capacity inherent in the human mind of creating 'newness', and the overruling need for self-criticism in the search for truth.

SOME PROBLEMS OF PARTHENOGENESIS

IN his presidential address to Section D (Zoology), Prof. A. D. Peacock is reviewing the more important researches of the past twenty years on animal parthenogenesis and indicates their bearing on certain fundamental biological questions. Parthenogenetic phenomena have recently been recorded in several large groups previously not known, or dubiously known, to be parthenogenetic. The only main groups in which such phenomena are unknown are Protozoa, sponges, ascidians and reptiles, but the indications are that parthenogenesis, if only rudimentary, is more common than generally supposed. Of great interest is Muldal's discovery of obligatory parthenogenesis in four genera of earthworms, facultative parthenogenesis in a fifth genus, and the polyploidy of the species concerned. Records and details of geographical parthenogenesis increase, Seiler's work on *Solenobia* moths and Suomalainen's on weevils being particularly striking. Each worker has shown independently the appearance of polyploid parthenogenetic races since the Quaternary ice period and their colonization of high-altitude inhospitable places, the ancestral diploid bisexual race remaining in the lower and warmer regions.

In cyclic parthenogenesis, for example in rotifers and waterfleas, there exists heterogony, the alternation of the bisexual and parthenogenetic modes of reproduction, and much discussion has centred around the problem of how the cycle of events is determined, whether by hereditary or by environmental factors. The recent work on rotifers by Hans Buchner and on waterfleas by Madeleine von Dehn, using the most refined techniques, amply confirms previous views that environmental factors determine the cycle and, further, shows that the main factor is the quality of food. Buchner also finds an inherent maximum potentiality for bisexuality (*Reaktionsnorm*) in individual races of rotifers and that the level of bisexuality attained in a race at a given time depends upon the strength of the environmental factors.

On parthenogenesis and sex, one problem is that of male production from unfertilized and haploid eggs as seen in the honey bee and Hymenoptera generally, also in rotifers and certain other forms, the phenomenon being unexplained by the classical theory of genic balance. In Whiting's theory of multiple alleles is found the best solution. It is based on genetical evidence. A sex segment on each of two homologous chromosomes of the diploid female exists in nine different alleles; the diploid female possesses two unlike alleles and is heterozygous; the diploid male, a rare phenomenon arising from certain pairings, has two like sex alleles and is homozygous; and the functional male arising from an unfertilized egg therefore carries only one sex allele and is azygous. Another problem regarding sex arises out of Seiler's intersexual *Solenobia* moths, which individually are shown *inter alia* to possess the same grade of intersexuality in all their organs. Seiler's interpretation is that his specimens possess a fixed grade of intersexuality from the embryo onwards, which conflicts with Goldschmidt's earlier time-law (*Zeitgesetz*) interpretation, based on his gipsy moth intersexes, that there is a switch-over from one sex to the other during development.

Early experiments by Loeb, Bataillon, R. S. Lillie and others on artificial parthenogenesis stimulated research on fundamental problems of reproduction, development and cell physiology. More recent work by the Runnström school, Tyler, Rothschild and others, has focused attention on the problem of the artificial and natural activation of the unfertilized egg. Remarkable successes have been obtained by Pincus and co-workers on mammalian parthenogenesis; they have obtained seven rabbit parthenogones, some alive, from eggs artificially stimulated *in vitro* and then transplanted into rabbit foster mothers. The regulation processes of the parthenogenetized eggs of rabbits as studied by Pincus, and of rabbit, sheep and rat, as worked out by Thibault, also receive attention. Other aspects treated comprise the extent and evolution of parthenogenesis and its role in reproduction and evolution; suggestions for researches suitable for biologists of all kinds; and the possible bearing of artificial parthenogenesis on human affairs.

ASPECTS OF SETTLEMENT IN THE OVERSEAS DOMINIONS

PROF. R. O. BUCHANAN's address to Section E (Geography) is a broad comparative survey of some historical conditions that controlled the process of the taking possession of land in areas of modern colonization. This process was spread over two centuries and a half, from the founding of the Dutch East India Company's settlement at the Cape in 1652 to the occupation of the Canadian prairies, which began at the close of the nineteenth century. The Dutch expansion eastwards from Cape Town took place before the Industrial Revolution, while the corresponding movement in Australia, New Zealand and the prairies of Canada reflected the differences in outlook and in material circumstances progressively produced by that revolution. In South Africa the official policy for a century and a half was that of the Dutch East India Company, conceived purely in the interests of its trading activities in the East Indies. In Australia in the earlier stages official policy was that of the Colonial Office. In New Zealand settlement was organized by colonization companies from 1840 onwards, and official policy was the

policy of these companies as agreed by the Colonial Office. In both Australia and New Zealand that policy was dominated from 1830 by the views of Edmund Gibbon Wakefield and his supporters.

These two sets of policies, South African and Australasian, though separated in time by a century and a half, were curiously similar in their insistence on small tillage farms in narrowly circumscribed settlements, and consideration is given by Prof. Buchanan to the process by which in all three countries the people on the spot evaded and defeated the cramping control of official regulations, and produced a moving pastoral frontier, in Francis Jackson Turner's sense of the term. This pastoral frontier area has survived only where the natural conditions are difficult, through low rainfall, as in South Africa and Australia, or rugged relief, as in New Zealand.

With the passing of control to the local governments, the more productive area was transformed, mainly through political action, into a farming frontier, with farms of a size capable of providing an acceptable family living, and therefore varying in size with the productivity of the area concerned. Unique to South Africa were the period of slavery and the struggle with the Bantu. The North Island of New Zealand with its Maori wars, born of incompatible usages in land holding, presents a partial analogy, though with significant differences. The settlement of the Canadian prairies differs from that of the southern dominions in coming so late (end of the nineteenth century) and in being so strongly influenced by American precedents. The quarter section of 160 acres for specialized wheat growing was not the final answer to the occupation of the prairies by a permanent agriculture, but it was a good first approximation, and it did solve at one stroke several of the problems that had taken South Africa over two centuries, Australia over one century and New Zealand over half a century to solve. These economic, political and administrative measures have left their imprint on the face of the land in the settled areas, and provide much scope for detailed studies in local historical geography.

FULL EMPLOYMENT IN RETROSPECT

FOR his presidential address to Section F (Economics), Prof. D. T. Jack discusses the problems of full employment.

Pre-war discussions relating to employment policies were conducted against a background of prolonged under-employment, and the main issue concerned the means of attaining continuous full employment through the maintenance of aggregate demand. The emergence of inflation and over-full employment did not appear as a pressing possibility. Similarly, at the end of the War in 1945, there was a widespread expectation that the experience of the years following 1918 would repeat itself and that in order to prevent a recurrence of substantial unemployment special efforts would be required to ensure that aggregate demand did not display symptoms of chronic deficiency. These expectations have not been realized, and in fact our main problem, which has not been adequately solved, has been precisely the development of inflationary pressures and the phenomenon of over-full employment which were neglected in pre-war discussions.

It is probable that an undue amount of attention is devoted to general movements of prices, wages, etc., and insufficient attention to relative movements within the same indices. Under conditions of full employment, relative price and wage movements have a particular importance in allocating resources, greater than their importance during periods of under-employment. Attempts to suppress the symptoms of inflation do damage to the normal working of the price and wage mechanism.

Consideration is given to the nature and effects of these inflationary pressures, the natural distortions in the structure of prices to which they give rise, the further artificial distortions which result from the attempts to suppress the symptoms of the inflationary process, and the recurrence of balance of payments crises. The view is taken that the appropriate treatment of these problems lies in the field of domestic policy rather than by means of international agreement. In this connexion reference is made to three reports by committees of experts set up by the Economic and Social Council of the United Nations, which appear to be preoccupied with the problem of maintaining aggregate demand as a means of dealing with a situation which had been anticipated but which has not as yet arisen. The recommendations of these committees have been unduly concerned with economic aggregates and they have had a pronounced inflationary bias.

Examination is also made of the tendency for price inflation to be followed by cost inflation, and in that connexion particular reference is made to proposals for the construction of a unified wage policy. On general grounds these proposals are not accepted; but further consideration is given to the suggestion that wages should be related to productivity either by means of a mechanical link with an index of over-all productivity, or with an index of productivity for the industry in which the wages are paid. These proposals are not commended. If the main problem of inflationary pressure can be tackled at its source these various devices, apart from their technical awkwardness, become superfluous. The experience of full employment emphasizes the importance of concentrating on this problem of inflationary pressure for future policy.

PROGRESS IN AERONAUTICAL SCIENCE AND ENGINEERING

IN his presidential address to Section G (Engineering) Sir Ben Lockspeiser points out that there has been a very great advance in aviation since the previous meeting in Belfast of the British Association fifty years ago. That occasion preceded the Wright brothers' successful achievement of powered flight by one year. Yet aeronautical progress has been such that last year nearly one-third of all the persons crossing the North Atlantic went by air. It is significant that the Wrights found it necessary to invent the wind tunnel and other techniques which now belong to the science of aerodynamics before they managed to engineer their first aeroplane. Aeronautical science and engineering have gone hand in hand in the evolution from the aeroplane which was a wooden skeleton to the stream-lined metal monoplane built of hollow shells in aluminium alloy.

The modern aeroplane has 'clean' lines: the external struts, bracing wires, undercarriage, etc., are no longer seen. These parts contribute nothing to the lift and are a liability on the engine. However, aerodynamic cleanliness means more than the absence

of unnecessary projecting parts. The stream-lines follow the surface and wasteful eddying is at a minimum. The lift-induced drag is inescapable, but is not the main contributor to the resistance in high-speed flight. For speeds of less than, say, 500 m.p.h. the remaining and larger portion of the drag is due to viscous effects. Much would be saved if the flow in the boundary layer next to the surface could be made laminar instead of turbulent.

The conditions for boundary-layer flow, which is mainly laminar, are very exacting. The brilliant mathematics of S. Goldstein and others has led to suitable designs, but the surface must have the smoothness of writing-paper and be almost free from waviness. Even then, it has been found in flight tests of 'laminar-flow wings' that dust particles and insects picked up at low altitude may promote the onset of turbulence in the boundary layer.

At speeds about 70 per cent of the speed of sound, it is no longer possible to regard the air as an incompressible fluid. The air is accelerated in its passage over the curved surface of an aerofoil, and the local velocity of sound is exceeded long before the aircraft itself reaches sonic speed. Shock waves then occur at the downstream ends of the regions of supersonic flow, and their formation is accompanied by a great increase in drag. The movement of shock-waves in the 'transonic' range of speeds leads to movement of the centre of pressure and consequently affects the equilibrium of aircraft and throws up problems of control and stability. At supersonic speeds a bow-wave is formed, and the flow becomes stable with no serious change of the centre of pressure as the speed or incidence is varied. The onset of shock-waves at high subsonic speeds may be delayed by reducing the acceleration produced by curvature; for example, by making the wings thin. The velocity component in the direction of maximum wing surface curvature may be reduced by sweepback. This solution has marked benefits, but they disappear at high supersonic speeds.

The efficiency of the conventional combination of engine and propeller falls at high speed, as the propeller—like the wing—is beset with 'compressibility' drag. The thrust necessary for transonic flight is now obtained by the combination of gas turbine and jet pipe, namely, the turbo-jet. This type of engine develops more thrust per unit of frontal area than any other type of air-consuming engine, but it may be considered to be still in its infancy. At sufficiently high supersonic speeds the pressure at the air intake is high enough to obviate the need for a compressor, and hence also to make the turbine superfluous. This is the principle of the ram jet—an engine without moving parts. Another type of power unit for use in special circumstances is the rocket, the characteristic feature of which is that the oxygen for combustion is self-contained within the fuel.

The development of light alloys of high strength has had much to do with the progress of aircraft structures, which themselves are characteristically different from any other. Considerations of strength, stiffness and fatigue properties at a minimum cost in weight decide the design. High flying speeds have involved high landing and take-off speeds, with the consequent replacement of landing fields by vast areas of concrete. Some revolutionary ideas to obviate the need for these are now being studied. The use of flying-boats and further application of the helicopter principle are other possibilities. The future in the air may well lie in the conquest of the ground.

ARCHÆOLOGY, FOLKLORE AND SACRED TRADITION

THE presidential address by Prof. E. O. James to Section H (Anthropology) traces the relation of archæology to sacred traditions. With the advance in knowledge and in the changed intellectual climate and social environment of to-day, the modification in the earlier evolutionary approach to the study of man is most apparent in the cultural aspects of anthropology. It is now widely recognized that so many factors have been evolved in the origin and development of human institutions and techniques, social structures and religious traditions that clearly defined unilineal systems of development cannot be maintained in relation either to the archæological evidence or to the underlying modes of life, belief and organization. Thus, the distribution and correlation of the palæolithic cultures in different parts of the world suggest that widespread movements of peoples and diffusion of techniques and ideas played an important part in the process of development, though not to the exclusion of independent invention and the influence of local conditions. In more advanced states of culture this is increasingly apparent.

With the arrival in Europe of the Crô-Magnons, and the groups of *Homo sapiens* allied to them, cultural progress became more rapid and complex, and among the achievements in the later stages of the last glaciation was the emergence of a sacred tradition. Its beginnings can be detected in the Mousterian ceremonial interments, it is true, but it was not until the Upper Palæolithic that a cultus began to find expression not only in respect of the disposal of the dead but also in the fertility emblems, commonly known as 'Venuses', and in the art of the decorated caves. To a sanctuary like Altamira, Lascaux or Cogul, recourse seems to have been made by generation after generation of hunters to control the chase by supernatural aid, to stimulate the propagation of the species on which they relied for their food supply, and to establish a mystic bond with providential sources of life and abundance.

When this sacred tradition became a spent force at the end of the Palæolithic (that is, in the Mesolithic), in due course, after the rise of husbandry and herding in the Ancient East and the subsequent diffusion of neolithic settlers from the third millennium onwards, its place was taken by a megalithic cultus distributed along the Mediterranean and Atlantic littoral to Brittany, the British Isles and the shores of the Baltic, with extensions through southern France to Sweden and in an easterly direction to India and Polynesia. Here, again, certain sacred enclosures (for example, Avebury, Carnac, Bethel and the *topes* at Sanchi in India), associated with holy persons or relics and transformed into a *locus religiosus*, became centres of pilgrimage and developed a cultus which persisted throughout the ages. Although all these sites and their rites were not generically connected and the product of a 'megalithic race', they cannot have been independently evolved in complete isolation from each other. On the contrary, as their structure and the legends connected with them indicate, they represent a cultural diffusion spreading from the Mediterranean to Western and North-western Europe. Once it was firmly established in a particular locality, however, the sacred tradition and its cultus have persisted from age to age.

This is illustrated in the long and complex history of the famous medieval shrine of Santiago de Compostela with its maritime legend which, it is contended, was of megalithic origin. In a modified form with different settings, the same tradition has recurred and survived south of the Minho in Portugal, and can be detected in many cult legends throughout the megalithic region (for example, the St. Martha story). Behind this widespread theme and its cultus lie the movements of peoples, for a variety of purposes, and the diffusion of culture, which characterized the rise of Neolithic civilization in the Ancient East, bestowing on certain sites and centres a permanent tradition of sanctity of sufficient endurance to enable pagan sanctuaries to become Christian shrines.

NERVOUS CONTROL OF THE MOVEMENTS OF THE ALIMENTARY CANAL

IN his presidential address to Section I (Physiology), Prof. R. C. Garry points out that, in spite of continuing interest and of steady research, our present attitude towards the nervous control of the alimentary canal differs little from that expressed with general acceptance more than fifty years ago by Bayliss and Starling. Yet many facts have since been elicited which appear not to conform to their original conception, and constructive attacks have been made on certain aspects. Nevertheless, for want of a better, we have still to subscribe, more or less, to the original hypothesis.

When entirely separate from the body, the intestine, if kept under suitable conditions, can still show co-ordinated movements. There must be some form of intrinsic control. Certain simple and local movements may be 'myogenic' and independent of the nervous elements in the gut wall. Peristaltic waves, however, may extend over a considerable length of gut, moving only caudad. Bayliss and Starling believed that peristalsis is governed by a reflex in the nervous myenteric plexus of Auerbach. This belief has been vigorously attacked from several sources, but modern work seems once more to emphasize the importance of the nervous element.

Much of the present uncertainty is due to our imperfect knowledge of the histology of the nervous plexuses in the gut wall. Are there receptors in the intestine? If so, what is their nature and where are they located? Do axons passing from the gut into the central nervous system make contact with nerve cells in the myenteric plexus? How many types of nerve cell are present in the wall of the intestine? How are the outgoing axons from the nervous system to the gut distributed to these nerve cells in the gut? Until the histologists can give an answer to these questions, we may be unable to interpret satisfactorily the nature of the control of the intrinsic movements of the intestine.

In the intact animal the autonomic nervous system undoubtedly influences the activity of the gut; and it is attractive to believe that the two divisions of the autonomic system, the orthosympathetic and parasympathetic, oppose one another, as they are known to do elsewhere in the body. Yet there are many observations inconsistent with this view. It may easily be that our experimental approach is crude and is responsible for the observations inconsistent with theory. In spite of everything, the original conception still holds the field, partly due to its inherent logical tidiness and partly to its appeal to our preconceived notions.

At the cranial and caudal ends of the gut there is less dubiety. There the alimentary canal seems to lose much of its autonomy and to come more intimately under the influence of the nervous system. The complex acts of swallowing, vomiting and defæcation are undoubtedly governed by elaborate reflexes which control not only movements of the gut but also the behaviour of skeletal musculature.

In the body, the intestine not only receives nerve impulses from the central nervous system, but also sends impulses into the nervous system. Recent work has disentangled the routes followed by these ingoing nerve impulses, but we still do not know exactly how and where they arise. Neither do we understand the normal function of these ingoing nerve impulses. They may give rise to sensation, but apparently only when the normal gives place to the abnormal. Moreover, the controversy concerning the nature of sensation from the viscera is by no means settled. Once more, only at the extremities of the gut can we form a clear picture of the nature and functions of the impulses which pass inwards into the central nervous system. It may easily be that a better understanding of the nature of the nervous control of the intestinal movements will depend not so much on the physiologist as on the histologist and morphologist.

THE ASSESSMENT OF PERSONALITY

PROF. P. E. VERNON, in his presidential address to Section J (Psychology), discusses "The Assessment of Personality".

Personality may be regarded as an organized and fairly stable structure which includes all the social and emotional traits, the interests and attitudes and complexes that underlie a person's behaviour. Difficulties in studying it scientifically and assessing it arise, first, because many of its links are repressed into the unconscious mind. Secondly, it is not purely a property of the individual, but varies with the particular social environment. Thirdly, personality traits are generalized inferences from behaviour; they involve subjective interpretation by an observer, and thus depend largely on the outlook and mentality of the observer and on the interaction of his own personality with that of the individual. Nevertheless, considerable progress has been made in recent years in the theoretical analysis, and in experimental investigations, of personality. But we do not possess, and cannot expect to devise, simple, straightforward tests comparable in reliability and validity to our tests of aptitudes and attainments.

Many experiments show wide discrepancies between the personality judgments of different interviewers, or observers, of the same individuals. In personnel selection work, predictions of vocational or educational suitability, based on interviews of recruits, school pupils or university students, are often poorer than predictions based on a few psychological tests of aptitudes. Some vocational interviewers are relatively successful; many employers, teachers and psychologists are very unsuccessful. More intensive 'clinical' or psychiatric interviewing, designed to elicit a complete picture of personality structure, may merely result in more biased assessments. Closeness of acquaintanceship also tends to make for greater inaccuracy.

Among the many objective tests that have been tried, physical or physiological indices of temperament (for example, somatotypes or the psychogalvanic reflex), and simple tests of perseveration, fluency and variability are generally unpromising. More realistic tests situations can be engineered for bringing out such traits as honesty, persistence, emotional instability and sociability; but these methods are too elaborate for selection or guidance purposes. Indirect observations or measurements of the manner of reacting to various performance or 'stress' tests are more useful, in skilled hands. The group observational methods popularized by War Office selection boards are widely applied, and provide a useful extension of the interview. But they are essentially subjective and greatly dependent on the skill of the observer. So-called projective techniques also involve so much interpretation that they are almost useless for vocational and educational predictions, though valuable for differential diagnosis of abnormal personalities. Personality questionnaires are genuinely useful at a fairly sophisticated level for assessing interests and social attitudes, and even for measuring certain social and emotional traits, provided that the questions are sufficiently disguised—for example, by the 'forced choice' technique—and that the scoring keys are empirically validated. Ordinary personality ratings (for example, on pupil record cards) are of little value, though a number of techniques have been devised for making more effective use of acquaintances' judgments. The chief difficulty in supplying the psychologist with a useful set of instruments for personality assessment is the amount of psychological and statistical investigation needed, and the shortage of qualified investigators in Britain.

ANATOMY OF METABOLISM IN HIGHER PLANTS

THE full title of the presidential address of Prof. Meirion Thomas to Section K (Botany) is "The Anatomy of Metabolism in Higher Plants: Total Metabolism, Metabolic Processes and Partial Reactions".

The axiom is that transformation of matter and energy lies at the root of all biological events. Specific to every organism, or a component cellular part, is its total metabolism. The physiologist accepts this concept and abstracts from it metabolic processes for special study. Categories are very mixed in the chapter headings: photosynthesis; respiration; acid, nitrogen or fat metabolism, and so forth. Respiration is a traditional term for the absorption of oxygen and a related production of carbon dioxide by a living organ. The gaseous exchange may be an external manifestation of an integral internal process, having a definite beginning and end. Current researches bear on questions concerning the beginning of the process and the integration of events. The outcome of these researches will determine whether or not the traditional term will survive as something more than a counter with which to reckon. When analysis and synthesis can proceed no further, the term may still retain a biological meaning. The crucial point may turn out to be that action is, or is not, attributable to organization within a visible or invisible cell structure. The known facts about certain other processes point to the possibility of direction by organized enzyme complexes. However, the abstractions from total metabolism implied in many chapter headings in current use are plainly made for classificatory convenience. They are artificial and not natural.

Analysis of total metabolism into component fractional processes that still retain their characteristic pattern has not proceeded very far. Worthy progress may, however, be claimed for the study of the ultimate fragments of which abstracted metabolic processes and, consequently, total metabolism, are composed. These fragments are the partial reactions, the physicochemical realities. The elucidation of the functions of key partial reactions will loom increasingly large in the future study of physiology. With the achievement of a correct synthesis from biochemical knowledge about partial reactions, the pattern of a metabolic process would emerge. Ideally, analysis and synthesis would meet in the abstracted process, and we would see in the whole the harmonious working of the parts, relating functional actions, whether single events or blocks of events in a process, to the maintenance of individuals or the perpetuation of a race.

It is asserted that, for higher plants, well-authenticated facts about reaction sequences and linkages are still in very short supply. Problems of intermediate metabolism are stated. Methods used in fact-finding are outlined, and some of their limitations indicated. Detailed treatment is given to three aspects of carbohydrate catabolism, namely, malic acid production in crassulacean acid metabolism, and anaerobic and aerobic respiration. The results of broad physiological studies involving the measurement of gaseous exchange are related to our steadily growing knowledge of partial reactions in these abstracted processes. However, some emphasis is laid on the existence of gaps in our knowledge, especially of stages in the aerobic catabolism of carbohydrates in higher plants, and on the need for continued efforts to verify, by experiment, hypotheses based largely on work with animal tissues, yeast and bacteria.

EDUCATION OF AFRICANS IN EAST AND CENTRAL AFRICA

THE subject of the presidential address to Section L (Education) raises so many issues that Mr. A. L. Binns has had to select for discussion in his address only a few of the many problems which the title indicates. Mr. Binns points out that the history of education in the seven British territories of East and Central Africa seldom goes back more than a quarter of a century, and he is full of admiration for what has been done in such a short time by so few people with such slender resources. These territories depend for the most part on agriculture, which is often very primitive in its methods and implements, and the funds available are very small in comparison with the expenditure to which we are accustomed in Great Britain.

Education is administered by the Colonial Civil Service, working in co-operation with the Christian Churches except in those areas where the people are Mohammedan. A comparatively small number of European teachers is working very hard to train Africans to follow in their footsteps. Owing to difficulties of finance, religion and communications, the training of the African teacher often leaves much to be desired in both content and method, but a

great effort is being made to improve matters. The teachers' training centres must be small by British standards, but at present some of them produce less than a dozen teachers annually and lose in both efficiency and economy for that reason. The curriculum followed in the schools has the aim of enabling the Africans to lead the fullest possible life in their own environment, and to improve that environment as quickly as possible; but some Africans would like to copy too closely the aims and methods of European education which are, of course, related to entirely different environment, culture and traditions. Some Africans are also prone to mistake the means for the end and to regard education as designed to enable them to pass examinations rather than to lead a good life. Many people in Great Britain fall into the same error, but it is natural that a people who are emerging from a primitive way of life should be especially open to the temptations of an education academic and examination-ridden. Language is a real difficulty in most of the schools of these territories, for the tribal vernaculars are very numerous, they arise from a number of language roots, and they are often limited to such a small number of users that these languages have little literature and sometimes even no school text-books, simply because the market is too small to make printing economically possible. A lingua franca to be used in addition to the tribal vernaculars is essential to progress, and it must be a lingua franca current over a wide area, with a rich literature and fully equipped for use in technical education and in commerce. Swahili, which has been used to some extent as a lingua franca, fails in some of these respects but has stood in the way of a better common language.

The population of many of these territories is increasing very fast, and increased productivity is essential. There is here a vicious circle, for increased productivity is a condition of the spread of education for financial reasons, while productivity cannot expand rapidly until we have an educated population. So many other things depend on the advance of education in East and Central Africa that the vicious circle thus described must be broken into to raise the moral stature as well as the material resources of these countries, and to enable their inhabitants to lead a fuller life.

BRITAIN'S FOOD SUPPLIES

In his presidential address to Section M (Agriculture) Dr. N. C. Wright opens with a reference to the leading part which the British Association has always taken in relating nutritional needs to national life, notably by the pioneer survey of food consumption and expenditure made by a special Committee of the Association in 1880. This survey had already shown the increasing dependence on overseas food supplies which accompanied Britain's rapid industrial development in the nineteenth century. During the fifty years between 1880 and the 1930's this trend was continued, until in the immediate pre-war years Britain relied on imports to the extent of some 70 per cent of the total calorie value of the food supplies. This excessive dependence on overseas supplies was inevitably accompanied by the neglect of the food-producing potentialities of British agriculture.

With the outbreak of war in 1939 the country had to face drastically reduced overseas food shipments, which by 1942 had fallen to only half the pre-war figure. To meet this serious menace to the food supply it was necessary not only to re-plan the import programme but also to re-develop British agricultural production. From the nutritional aspect there were three main objectives in planning this re-orientation of the country's food supplies: first, to ensure an adequate calorie-level in the national diet; second, to furnish sufficient supplies of 'protective' foods, particularly for the vulnerable groups of the population; and third, so far as possible to provide a diet which was reasonably varied and palatable. The first objective was achieved by expanding substantially the home production of crops which furnished maximum calories for direct human consumption, for example, wheat, potatoes and sugar-beet. This inevitably involved substantial reductions in the livestock population, notably in the numbers of pigs and poultry—though such reductions were partially offset by large increases in the home output of coarse grains. The second objective was achieved partly by increasing the supplies of liquid milk and subsidizing its consumption, partly by expanding the acreages under vitamin-rich vegetables, and partly by adopting processing techniques designed to increase the 'protective' value of certain staple foods such as bread and margarine. The third objective was achieved by changing the pattern of imports to include a higher proportion of the more palatable and concentrated foods, and by increasing the home production of certain highly flavoured crops. As a result of these combined measures the nutritional value of the diet was actually improved during the War.

The immediate effect of the cessation of war was to create greatly increased demands on the world's available food supplies. Simultaneously Britain had to face the loss of Lend-Lease aid. Since animal products represented the most expensive drain on the country's currency, the main objective of the 1947 agricultural expansion programme was to re-expand the livestock population; but to do so not only on the basis of substantially increased dependence on home-produced animal feeds but also without any appreciable reduction in the home contribution to the total calories of the national diet. The extent to which this was achieved is shown by the figures for home production in 1950.

Although both the war and post-war increases in home food production were associated with marked changes in the pattern of land usage, they were also largely due to technical improvements designed to increase both yield and productive efficiency. These improvements included very substantial increases in fertilizer usage, in farm mechanization, in crop protection methods, and in the productivity of crops and stock, as well as of grassland.

An examination of the country's future food requirements indicates that largely owing to the gradual equalization of demand between different income groups these are likely to increase. At the same time, both the availability of world supplies and Britain's balance of payments problem are likely to limit the country's ability to purchase food from overseas. The need for a further expansion in home production is therefore assured. Whether such expansion will involve a further marked re-orientation in the pattern of land usage cannot be forecast, but there is no doubt that even within the present pattern there is still ample scope for improvement by the wider application of science to farming practice.

LOCAL SCIENTIFIC SOCIETIES

THE title of the presidential address to the Conference of Delegates of Corresponding Societies being delivered by Mr. J. A. S. Stendall is "Problems and Responsibilities". After tracing the history of societies in Northern Ireland and directing attention to men eminent in their own spheres of activity, Mr. Stendall turns to the decline in publications issued by local societies. This, he suggests, is possibly not due to lack of interest on the part of those responsible, but rather to present-day conditions. Fewer reports and proceedings of societies are being published and still fewer records of accomplished work made available, owing to the prohibitive increase in printing costs. This is to be deplored. Mr. Stendall thinks that societies should subsidize regional journals rather than attempt their individual publications and in this way cut their own costs, allow for an increase in size of the journals, bring all regional records together and reduce time-lag in the publication of important papers.

Following a brief account of the natural scene in Northern Ireland, an appeal is made to members of the local societies to give more consideration to the importance of preservation by law of several well-known areas of great interest—scenically, archæologically and naturally. Great Britain has scheduled many such areas, but nothing in this respect has been done in Northern Ireland, notwithstanding favourable recommendations contained in the 1946 Interim Report of an officially sponsored Planning Advisory Board on Amenities.

An appeal is made for the control of ivy growth, especially on trees. Locally many fine trees have been killed by ivy strangulation; to-day there are numbers tending that way, while potential victims are legion, especially those growing along roadsides. Similar conditions appertain farther afield than Northern Ireland.

Turning to local achievements in the preservation of Nature, Mr. Stendall refers to the value of the Wild Birds Protection Act (N.I.) 1931, which swept away outmoded legislation, similar to that which holds in other parts of the United Kingdom to-day, ranging as it does back into the 'eighties. Northern Ireland, fortunate in being a compact area, lends itself to the now admitted justifiable experiment of deeming all species of wild birds to be protected, with the proviso that any undesirable members of the family could be contracted out, while a close season is given to birds of sport. The Act is administered by the Home Office of the Northern Ireland Government, with a special committee to advise the Minister. At the moment, there are seventeen species completely unprotected, two species can only be taken on enclosed land, while sporting birds of winter can have their close season altered and even be given complete protection for a definite period if necessary. All nests and eggs are protected, except those of the blacklisted species. The Minister has the power to transfer species from, and to, complete protection, while police have to be able to recognize but few species. Mr. Stendall suggests that local societies could do much to bring about legislation of a like nature in Great Britain.

OBITUARIES

Sir Jack Drummond, F.R.S.

THE insensate murder, on the night of August 4, of Sir Jack Drummond, together with his wife and their twelve-year-old daughter Elizabeth Anne, will have brought rage and grief to many hearts. Debonair would be the best single word to describe him; he attracted friends as the sparks fly upwards.

He was born in 1891. The history of his scientific work typifies and illustrates the development of biochemistry in Great Britain. Graduating from Queen Mary College and King's College, London, he became a research worker at the Royal Cancer Hospital, London, in 1914, and remained there for five years, when he was appointed reader in physiological chemistry at University College, London. This appointment, in which he succeeded the first reader in the subject to be created in the University, Dr. R. H. Aders Plimmer, was to the staff of the Department of Physiology. The post was made into a professorship in 1922, the Department then being known as the Department of Physiology and Biochemistry, which title it retained until his resignation in 1946 to become director of research to Boots Pure Drug Co., Ltd., after which a separate Department of Biochemistry was created.

The long list of Drummond's published papers emphasizes the unfolding of the subject of biochemistry. He had begun work on nutritional subjects, particularly on the so-called 'accessory substances', while at the Royal Cancer Hospital, and under the influence of Casimir Funk. In 1922 he was publishing the results of a search for the fat-soluble factor, then called vitamin A, and investigating its origin. At that time, although Mellanby had shown the antirachitic properties of the factor, it had not yet been separated into the A and D fractions—this happened about 1924. He passed on to study high protein diets, further properties of the non-saponifiable fraction of cod liver oil, and to the antirachitic properties of irradiated sterols, in 1925. The following year he went back to the question of the chemical nature of vitamin A, discussed its possible relation to carotene, which was rejected because he could not confirm the growth-promoting action of the latter, and he evolved the arsenic trichloride colour reaction. After working for two years on vitamin B in relation to diet and inanition, he returned in 1930–31 to the question of the relation of vitamin A to carotene, and this he now confirmed, explaining the former failures by the fact that the carotene had been given in solution in ethyl oleate, which oxidized easily and led to destruction of the carotene. For the time it appeared that carotene and vitamin A were, in fact, identical; but in 1932 T. Moore, of Cambridge, showed that the vitamin was formed from carotene in the body, and this Drummond confirmed.

Attention was next turned to more practical questions of the nutritive value of bread, the effects of milling, of the seasonal alterations in milk, and of the effects of fat-free diets; he also worked on vitamin E, which had recently been isolated.

It must be mentioned that nearly all this large amount of published work was carried out in collaboration with others, and they were many and often

distinguished, or destined to become so; Drummond was, however, the senior partner in most of these publications. I think he exerted much more influence through his inspiration of junior colleagues, and by his example of first-class work than by any actual event of discovery, in which, despite immense efforts, he was, on the whole, not over fortunate. That he played a very large part in the general development of the biochemistry of nutrition nobody can doubt; but it was more by example, by the application of first-class chemistry, by his innate appreciation that mere chemistry is not enough, and by the co-ordination of wide chemical with biological knowledge rather than by resounding discoveries that he did so.

When the War came in 1939, he was clearly indicated as the most suitable person for the responsible post of scientific adviser to the Ministry of Food, which he held until 1946, in the later years of the period being also adviser on nutrition to the Allied Post-War Requirements Bureau and S.H.A.E.F., and adviser on nutrition to the Control Commissions for Germany and Austria (British Element). He was knighted in 1944, and shortly afterwards was elected a Fellow of the Royal Society. Great Britain owes to Jack Drummond and to the Minister, Lord Woolton, who gave him a pretty free hand, an incalculable debt for the fine work they did in connexion with the British rationing system, which was finely conceived, brilliantly executed, and a pattern to all nations.

Drummond was interested in food from every aspect; he was a very good judge of food and knowledgeable as to its preparation, and he brought, as often as he could, to good food, good fellowship. Very many have spent many a happy hour with him, enjoying good fare, good conversation, and good fun at one of his clubs, at some private dining club, which he always enlivened, or in his own home, where he was the perfect host. We shall all think, often and often, of those very well-spent evenings, and shall not forget.

Lady Drummond (*neé* Wilbraham) was his second wife; she was interested in history, and collaborated with him in the production, in 1939, of an entertaining book, "The Englishman's Food" (Jonathan Cape), which abounds in sound scholarship and humour.

'Jack' was full of energy and enterprise, and with a lively sense of humour, which extended to telling stories against himself. He had travelled widely, and with wide-open eyes. Hatred was foreign to his nature, though he freely expressed amused contempt for any kind of pomposity or priggishness; to some, therefore, he might have been unacceptable. Beneath the twinkling eye there was, nevertheless, a steely inflexibility of purpose, and he could be devastating towards incompetence and astringent to fools. Lecturing came easily to Drummond; he was bright, informative and had a gift for popular exposition; accordingly he gave many popular lectures to large audiences, both in Great Britain and in the United States, and these lectures were greatly enjoyed.

His connexions with the industrial aspects of biochemistry, and especially with the food industry, were close, and mutually beneficial. Few realized more clearly than he that our standard of living, together with the sweets of academic life, represent the cream skimmed from industrial endeavour, and he probably supplied more young men for industrial undertakings than any other three biochemists put together; these young men did him great credit, and they not infrequently gained distinction in both pure and applied science.

Very many young people owe to Sir Jack Drummond their start in life; he liked young people, and put on no professorial airs for their benefit. If any memorial to him is to be created, he would have liked nothing better than something which would enable capable young people to receive an encouraging start, such as he gave to so many. It would also keep alive the name, for those whose loss it was not to have known him, of a great and lovable personality.

C. Lovatt Evans

The late Sir Jack Drummond was a man of outstanding ability. He was a scientist with an international reputation as one of the leaders in developing what has been called the newer knowledge of nutrition. By applying the scientific method of approach to the administrative problems in the Ministry of Food he made a great contribution to the success during the Second World War of food policy, the outstanding feature of which was the special provision for the nutritional needs of mothers and children. The resulting big improvement in the health and physique in the rising generation in a time of acute food shortage was a remarkable achievement. As one of those who got this policy adopted, and for his work in helping to get it carried through, he rendered great service to Great Britain.

Boyd-Orr

Mr. J. R. Park

British applied science has suffered a severe loss in the untimely death of Mr. J. R. Park, a managing director of the British Oxygen Co., Ltd. Mr. Park was born in London in 1902 and was educated first at Battersea Grammar School and then at Queen Mary College, where he graduated in chemistry. After a short period on the staff of Westminster Technical College he worked as an analytical chemist in industry for a number of years in Britain, followed by a year in a French firm.

In 1929 Mr. Park joined Imperial Chemical Industries, Ltd., Billingham Division, where he remained until 1945. For a time he worked there as a plant manager, but soon he switched over to the research side. The production of hydrogen, the hydrogenation of coal, the ammonia synthesis and methanol synthesis were some of the fields which occupied him in the years up to the Second World War, when he had advanced to the position of ammonia research manager. He was also connected with the design of oil hydrogenation plant, and in the first year of the War was responsible for the design of various other plants.

I made his acquaintance in 1941, when Park was put in charge of the I.C.I. Billingham research team working on the British Atomic Energy Project. His quick grasp of problems, his strong scientific background and his understanding of large-scale industrial processes formed a combination that contributed greatly to the success of the enterprise.

In 1945 Park was asked to organize a research department in the British Oxygen Co. He did this with outstanding success, creating within a few years a large and flourishing research organization practically from scratch. His worth was quickly appreciated;

in 1948 he became assistant managing director, and soon was promoted to the post of managing director. It is largely due to Park that the British Oxygen Co. has been transformed from an undertaking relying mainly on foreign patents into a modern enterprise standing on its own feet in the field of research and development. Park was one of the all too small group of first-class chemical technologists who are essential for the economic future of Great Britain; his death leaves a gap which will be felt for a long time. His friends mourn the passing of a personality of wide interests and great charm, and of a warm-hearted and loyal companion. F. E. SIMON

WE regret to announce the following deaths:

Sir Frederic Kenyon, G.B.E., K.C.B., during 1909–30 director and principal librarian of the British Museum, on August 23, aged eighty-nine.

Dr. Albert Mansbridge, C.H., founder and first secretary of the Workers' Educational Association, on August 22, aged seventy-six.

NEWS and VIEWS

The Nature Conservancy: Captain C. Diver, C.B., C.B.E.

CAPTAIN C. Diver is retiring on December 1 from the post of director-general of the Nature Conservancy. He was appointed to his present post four years ago to implement the Government's decision to establish the Nature Conservancy. After being invalided out of the Army, in 1919 he was appointed to a clerkship in the House of Commons and remained in the service of the House for the next twenty-nine years, relinquishing his appointment as principal clerk of committees to take up his present post. Throughout the Second World War he was clerk to the Select Committee on National Expenditure. In the field of biology Capt. Diver has worked as an amateur. Very early he developed an interest in land and freshwater Mollusca and a little later in the mosses. After the First World War, he received much help and encouragement from Bateson, and collaborated with Boycott and others in experiments on the genetics of inverse symmetry in *Limnæa*. He also studied the distribution of genes in natural populations of *Cepæa*, and the behaviour and web-building of the garden spider. In 1930 he began the ecological survey of South Haven Peninsula, Studland, on the Dorset coast, and soon enlisted the help of Prof. R. D'O. Good and many others. This work, for which he received a Leverhulme grant, continued steadily for the next nine years until brought to an abrupt close by the declaration of war. He was a member of the Nature Reserves Investigation Committee set up in 1942 under the auspices of the Society for the Promotion of Nature Reserves, and he was largely responsible for the contents of its report. This report furnished the basic data for the work of the Wild Life Conservation Special Committee which was appointed in 1945 by the Ministry of Town and Country Planning to work in conjunction with the Hobhouse Committee on National Parks. He took a leading part in the work of the Special Committee, the report of which ("Conservation of Nature in England and Wales". Cmd. 7122. 1947) he drafted at the unanimous request of the Committee. It was largely informed by his ideas and policies, and the acceptance by the Government of its main conclusions brought the Nature Conservancy into being.

Mr. E. M. Nicholson, C.B.

MR. E. M. NICHOLSON, who has been appointed by the Nature Conservancy, with the approval of the Lord President of the Council, to succeed Captain Diver as director-general, is a charter member of that body. He brought to the service of the Conservancy a valuable combination of administrative experience and expert ornithological knowledge; and he assumes his new duties as one who not only was a member of the Wild Life Conservation Special Committee but has also taken an active part in the work of the Conservancy since its inception. During the War, he served in the Ministry of Shipping, later the Ministry of War Transport, where as head of the division in charge of Middle East supplies he was responsible for sending out the Kerr–Worthington scientific mission. From 1945 until May of this year he was secretary of the Office of the Lord President of the Council, and is a member of the Advisory Council on Scientific Policy. For the past few months he has been in Baluchistan as the leader of a United Nations Economic Development Survey team. Birds and ornithological affairs have been Mr. Nicholson's life-long interest, and he has published scientific papers and several books on this subject; in 1927 he organized and directed the Oxford Bird Census, in which university ornithologists, botanists and entomologists collaborated in field surveys; and in the two following years he organized the Oxford University expeditions to Greenland and to British Guiana. He has been secretary, vice-chairman and chairman of the British Trust for Ornithology and has taken a leading part in other ornithological activities.

Natural History at Edinburgh: Prof. J. Ritchie, C.B.E.

WITH the retirement of Prof. James Ritchie from the chair of natural history at the end of the current session, the University of Edinburgh will lose the services of a distinguished naturalist and inspiring teacher. In his student days he came under the influence of Sir J. Arthur Thomson at Aberdeen and proved a worthy successor to that line of all-round scientific naturalists of which Scotland is justly proud —a type all too rare in these days of specialization. A brilliant record as a student saw the award of an M.A., a B.Sc. and in 1912 a D.Sc. In 1907 he entered the Royal Scottish Museum as an assistant and in 1921 became keeper of the Natural History Department. In 1930 he was appointed regius professor of natural history in Aberdeen and transferred to the chair at Edinburgh in 1936. Among the other posts he has filled are: five periods on the council, one as secretary and two as vice-president of the Royal Society of Edinburgh, president of Section D (Zoology) of the British Association, editor of the *Scottish Naturalist*, vice-president of the Zoological Society of Scotland and membership of various bodies concerned with the conservation of wild life.

His zoological researches commenced with a series of papers on Hydrozoa but soon extended to other marine invertebrates, land and water vertebrates and archæology. One of his interesting economic suggestions, a method of keeping the submarine shafts of an electricity station free from blocking by the invasion of mussels, has been in successful operation since 1927. It is not possible in a brief note to do justice to his remarkable energy and enthusiasm nor to the wide range of his knowledge and interests. His services were recognized by the conferment of a C.B.E. in 1948 and an honorary LL.D. by Aberdeen this year. His skill in drawing is reflected in all his work, and outside scientific circles has been recognized by the Royal Scottish Academy, which has exhibited a number of his delightful water colours. A most approachable man, he has always been ready to share his knowledge and to encourage the humblest of inquirers. Many have enjoyed his loyal friendship and some perhaps a round of golf with him.

Dr. M. M. Swann

Dr. Michael Meredith Swann has been appointed to succeed Prof. Ritchie. Educated at Winchester and Cambridge, Swann, after graduating in 1940 with a first-class in zoology, joined the Intelligence Corps, served in Iceland as a captain instructor in arctic warfare, benefiting by his earlier experience with the Cambridge Iceland Expedition of 1939, and was thereafter engaged in operational research in Great Britain and Normandy. When, as lieut.-colonel in the Scientific Adviser's Branch of the War Office, he was demobilized in 1946, he returned to the Zoology Department at Cambridge as temporary demonstrator, with a research fellowship at Gonville and Caius College. He has been a University demonstrator since 1948. Dr. Swann has devoted himself actively to the investigation of the cell, and his studies have followed three main lines—the refinements of mitosis, the fertilization reactions of sea-urchin eggs, and the mechanical properties of cell-membranes. In the first, his Ph.D. thesis (1950) was on "Structural Factors in Mitosis", and with J. M. Mitchison he has elaborated the use of polarized light in the study of cell changes affecting membranes, mitosis and cleavage. In the second, in collaboration with Lord Rothschild, he has elucidated the responses of the sea-urchin egg to contact with spermatozoa, and in the last he, along with Mitchison, has attempted to link the processes of cell-cleavage with the physical properties of the cell-membrane. At the age of thirty-two years Dr. Swann is not the most youthful of Edinburgh's long succession of professors of natural history, but to better his record one must go back to 1804 and the appointment at the age of thirty of Robert Jameson, the teacher of Charles Darwin, Edward Forbes, Sir William Jardine, William Scoresby, John Goodsir and many other well-known naturalists.

Research at Edinburgh on Cancer

From the estate of the late George Fisher Melville, advocate, of Edinburgh, the sum of £270,000 has now become available for the encouragement of activities relating to "the care and cure of cancer". Some time ago, Messrs. Tod, Murray and Jamieson, W. S., of Edinburgh, in whose hands the affairs of the estate rest, sought the advice of representatives of the Royal Colleges of Medicine and of Surgery of Edinburgh and of the University, and with the help of this *ad hoc* committee so formed drew up a scheme for the appropriate utilization of this money. This scheme has now gained the approval of the Court of Session. The next step will be the formal approach by the trustees to the Royal Colleges and to the University of Edinburgh requesting that each of these bodies shall nominate a trustee and three members of a permanent scientific advisory committee which will at once proceed to formulate recommendations for carrying the scheme into practical effect. Since the care of the patient is now a responsibility of the State, it is certain that the scientific advisory committee will be mainly, if not exclusively, concerned with the encouragement of research into the nature and causes of malignancy, and thus into the ways in which it may be prevented, treated and controlled. The hands of the trustees are not tied. They are empowered to nourish researches being undertaken in hospitals and elsewhere, to build and equip new laboratories, to institute research fellowships and to amalgamate or to form alliances with other bodies actively interested in the same general field of inquiry. In these days, opportunity of this magnitude knocks but very rarely upon the doors of Scottish academic institutions. The responsibility to be assumed by the scientific advisory committee is, therefore, exceedingly heavy. To exploit this opportunity to the best advantage to all concerned—to those who suffer and to those who seek knowledge that may give power to abolish suffering—will demand the exercise of much wisdom. Of this there is in Edinburgh a rich store.

Popular Interests in Science

An investigation into the interests of about 391 people (241 males, 150 females) who are taking science subjects in adult education classes showed that the females were more extreme in their preferences and dislikes than the males (*Health Educ. J.*, **9**, No. 4). Males were most interested in studying future advances and new discoveries and theories in science and, next to these, medicine, health and the industrial applications of science. Medicine and health were the most popular subjects for females, and almost as popular were pure biology and psychology. Neither males nor females took much interest in aeronautics or in the public direction and use of science; even less interest was shown in the work of scientific institutions and the results of science surveys and commissions. This may indicate that the 'ordinary' man is not fully conscious of the impacts of science on communal life or, perhaps, is little interested in the development of society as distinct from the individual. Confirmation of this investigation was obtained from a group of men in an Army education college. Although the men were not necessarily interested in science, their likes and dislikes were very similar to those of the younger men in the original group.

C. T. R. Wilson and the Cloud Chamber

The fourth in the series of attractively illustrated monographs dealing with the association of prominent men of science with the Cambridge Instrument Co., Ltd., is entitled "C. T. R. Wilson and the Cloud Chamber" (pp. iv+16; from 13 Grosvenor Place, London, S.W.1; 1952; free) and is written by S. Barron, with a foreword by Sir Lawrence Bragg. Reference is made, both in the foreword and in the text, to Wilson's skill and patience in building apparatus and to the remarkable success of the first complete cloud chamber constructed by Wilson in

the Cavendish Laboratory, Cambridge, in 1911. This instrument was the only one used by Wilson for his many subsequent researches and is preserved now in the Cavendish Museum where it is still, after forty years, as capable of producing perfect ray-tracks as when it was first demonstrated. In 1913, the Cambridge Instrument Co. obtained permission to make a cloud chamber similar to Wilson's original model; and the Company's first instrument, together with subsequent developments, such as the Wilson–Shimidzu raytrack apparatus (1921), the student's demonstration cloud chamber (1927) and the reciprocating cloud chamber built for the 1951 Festival of Britain, are all fully described and illustrated in the monograph.

Standards of Light at the National Physical Laboratory

"LIGHT" is the second in the series of pamphlets on units and standards of measurement employed at the National Physical Laboratory, Teddington (pp. 8. London: H.M.S.O., 1952; 6*d*.). The first dealt with the fundamental units of length, mass and time, and the third will deal with electrical units. In the pamphlet on light, the units and systems of measurement used in the Photometry, Colorimetry and Radiometry Sections of the Light Division of the Laboratory are defined. The units are those normally employed in reports and certificates issued by the Laboratory. Brief particulars describing the derivation of the units are provided, and reference is made to those which are accepted internationally. The topics discussed in the photometry section of the pamphlet are the candela, the unit of luminous intensity; the lumen, the unit of luminous flux; the distinction between the units of illumination on the British and metric systems; the stilb and the nit; the scotopic system of photometry; and colour temperature. The requirements of the standard trichromatic system of colorimetry adopted by the Commission Internationale de l'Eclairage are set out clearly in the colorimetry section; and, under the third heading of the pamphlet, "Radiometry", the instruments, particularly the Callendar radiation balance and its more recent successor the Guild drift radiometer, for the measurement of the rate of transference of energy by electromagnetic radiation, are briefly discussed. Industrial and research laboratories will find this series of pamphlets most helpful in interpreting test certificates and in ensuring that results of measurements are expressed in agreed and internationally recognized units.

Principles of Extraction and Refining of Metals

THE Institution of Metallurgists has published the five lectures on the "Principles of the Extraction and Refining of Metals" given under the presidency of Mr. E. W. Colbeck at its refresher course in 1950. Starting off with an introductory lecture on the use of physical chemistry in extraction operations, which is concerned mainly with thermodynamic principles, the place of mineral dressing in extraction metallurgy is then considered; this is, in the main, economic and technical. A lecture of unusual interest on the principles of ore reduction, by Prof. C. W. Dannatt, goes far towards systematizing the large number of procedures which are used for obtaining crude metal from its ore. The fundamentals of the production of ingots are then discussed, and the course is concluded by a lecture on the principles underlying refining processes, using the fundamental chemical principles previously outlined. All who are concerned with the extraction and refining of metals will find in this short monograph a large amount of material of direct interest, much of it by no means easy to find, nor so well digested, elsewhere. As is said in the concluding paragraph of the last lecture: "The refiner will find it vastly to his advantage to employ thermodynamics in order to recognize both the results which may theoretically be achieved in the ideal process, and those which are inherently impossible under his conditions of working".

King George III Collection of Scientific Instruments

A DESCRIPTIVE catalogue of the King George III collection of scientific instruments, issued by the Science Museum, London (pp. 92+8 plates; London: H.M.S.O., 1951; 7*s*. 6*d*. net), is of interest in throwing light on the activities of individual instrument-makers practising during the latter half of the eighteenth century. The catalogue is divided into sections according to the various branches of science recognized at the present time, for it should be realized that in the days of George III scientific specialization was not known, since the philosophers—as they were called—did not confine their studies to one branch of knowledge. The sections of the catalogue include mechanics, heat, pneumatics and hydrostatics, chemistry, astronomy and time measurement, optics, surveying and mathematical instruments, acoustics, magnetism, electricity, manuscripts and miscellaneous. The catalogue is illustrated and concludes with notes on the location of the other portions of the original collection and a list of makers of the instruments.

Colonial Plant and Animal Products

IN the latest issue of the quarterly journal of the Colonial Products Advisory Bureau (Plant and Animal) (2, No. 3), R. H. Kirby continues his series of articles on seaweeds in commerce. Besides accounts of the use of agar-agar in the British Commonwealth and other countries, Kirby also describes the manufacture of algin in the United States and other parts of the world. Other articles include one on aromatic grasses of commercial importance by E. Brown and W. S. A. Matthews, and the market for mangoes and mango products by E. H. G. Smith. Reports of recent investigations at the Colonial Products Advisory Bureau include that on the use of trigona wax from Tanganyika, manila hemp from Malaya, pewar or peach nuts from Trinidad, a description of drying trials with goat skins in the Sudan and the possibilities of using cocoa husks from the Gold Coast as a source of furfural.

Annals and Magazine of Natural History

FOR a century and a quarter the *Annals and Magazine of Natural History* has held an honoured place among biological journals; all-embracing in its earlier years, it has of late tended to include particularly systematic and morphological papers in zoology, palæobotany and palæontology. The proprietors of the journal, Messrs. Taylor and Francis, Ltd., with the support of the editorial board, have now decided to widen its scope by combining with it the *Journal of Botany*, which had to cease publication during the Second World War. The editorial board, Sir Guy Marshall, Dr. W. T. Calman, Prof. H. L. Hawkins and Mr. W. N. Edwards, will thus have the assistance of Dr. George Taylor, keeper of botany

in the British Museum (Natural History), and in view of the importance of the entomological papers in the *Annals*, Mr. E. B. Britten, of the Department of Entomology at the British Museum, is also to join the board. Biologists will welcome the extension of the field of this old-established journal and wish it a new lease of life.

Forty Years of X-Ray Diffraction : Anniversary Meeting in London

The X-Ray Analysis Group of the Institute of Physics is holding a meeting at the Royal Institution, Albemarle Street, London, W.1, during October 24–25, in celebration of the fortieth anniversary of the discovery of X-ray diffraction by Friedrich, Knipping and von Laue (see *Nature*, June 7, p. 949). After an opening historical address by Sir Lawrence Bragg, four papers will be read : "The Growth and Scope of X-Ray Crystal Analysis", by Prof. J. D. Bernal ; "Chemical Problems", by Dr. D. Hodgkin ; "X-Ray Analysis and the Metallic State", by Prof. G. V. Raynor ; and "The Application of X-Ray Analysis to Protein Structure", by Sir Lawrence Bragg. A commemorative dinner will be held on October 24, in the Criterion Restaurant, Piccadilly Circus, at which the guests of honour will be Prof. M. von Laue and Prof. J. M. Bijvoet. During the two days of the meeting there will be an exhibition in the Royal Institution of historical X-ray apparatus, etc. The meeting is open to all. Application forms for attendance (to be returned by September 20) and further information can be obtained from the Deputy Secretary of the Institute of Physics, 47 Belgrave Square, London, S.W.1.

Royal Photographic Society : Annual Exhibition

The ninety-seventh annual exhibition of the Royal Photographic Society will be opened by the American Ambassador, Mr. W. S. Gifford, on September 11, in the Society's House, 16 Princes Gate, London, S.W.7. It will be open to the public without charge from September 12 until October 12, inclusive, from 10 a.m. to 8 p.m. each day (Saturdays, 10 a.m.–5.30 p.m. ; Sundays, 2.30–5.30 p.m.). After the London display, the whole of the exhibition will be transferred to Leeds for the period October 25–November 23, and to Bristol for the period December 6–31.

Foot-and-mouth Disease Inquiry

The Minister of Agriculture and Fisheries has appointed a committee to review the policy and arrangements for dealing with foot-and-mouth disease in Great Britain, and to advise whether any changes should be made in the light of present scientific knowledge and the technical and administrative experience gained in recent years in this and other countries. The Committee is constituted as follows : Sir Ernest Gowers (chairman), Prof. E. D. Adrian, Colonel H. Cator, Dr. Ll. Wyn Griffith, Lord Hungarton, Prof. A. Robertson, A. R. Semple, and H. Woolley. R. A. Thorne, of the Ministry of Agriculture and Fisheries, has been appointed secretary to the Committee. Communications should be addressed to him at Hook Rise, Tolworth, Surbiton, Surrey.

Rajasthan Academy of Sciences : Officers

At the second annual meeting of the Rajasthan Academy of Sciences, Pilani, the following officers were elected : *President*, Dr. G. S. Mahajani, vice-chancellor, University of Rajputana ; *Vice-Presidents*, Dr. N. N. Godbole, director of industries and commerce, Rajasthan Government, and Dr. A. Mookerji, professor of physics, Birla College of Sciences ; *Secretary*, K. Ramamurti, Birla College of Science, Pilani. Mr. M. L. Schroff and Dr. M. L. Roonwal, as ex-presidents of the Academy, serve as vice-presidents, and Mr. Roshan Singh continues to be the treasurer.

Announcements

A discussion on "The Place of the Scientist in Civil Defence" has been arranged by the Royal Institute of Chemistry (London and South-Eastern Counties Section) with the Institute of Biology and the Institute of Physics (London and Home Counties Branch) and will be held on October 16 at 6.30 p.m. in the City of London School, Victoria Embankment, London, E.C.4. The principal speakers will be : Sir John Hodsall, Sir Charles Ellis, Dr. E. T. Paris, Prof. W. V. Mayneord and Prof. H. N. Rydon.

A seminar on polymer science is to be held in the Department of Chemistry, University College, London, W.C.1, during the autumn term. Eight lectures, by different speakers, will be given on Fridays at 4.30 p.m., beginning October 17. Visitors will be welcome.

A conference on the "Growth of Protozoa" will be held during October 24–25 at the New York Academy of Sciences under the joint sponsorship of the Academy and the Society of Protozoologists. The first day will be devoted to free-living forms, and the second to parasites. The programme is designed to be of broad biochemical, morphological and medical interest. The proceedings will be published in the *Annals* of the Academy. Further information can be obtained from the secretary of the Society, Prof. E. R. Becker, Department of Zoology and Entomology, Iowa State College, Ames, Iowa.

The Sixth Congress of the International Scientific Film Association will be held in the Maison de la Chimie, 28 rue St. Dominique, Paris 7e, during September 23–October 1. During the Congress there will be meetings of the General Assembly of the International Scientific Film Association, meetings of the permanent committees dealing respectively with medical, research, technical and industrial films, and a festival of scientific films. At the Congress Great Britain will be represented by the British Scientific Film Association, and further information can be obtained from the administrative officer of the Association at 164 Shaftesbury Avenue, London, W.C.2.

The Council of the City and Guilds of London Institute has conferred the fellowship of the Institute on the following past students of the City and Guilds College : L. H. Bedford, chief television engineer, Marconi's Wireless Telegraph Co., Ltd. ; H. F. Cronin, chief engineer, Metropolitan Water Board ; W. A. Del Mar, chief engineer, Habirshaw Cable and Wire Division, Phelps Dodge Copper Products Corp., United States ; H. J. B. Harding, director, John Mowlem and Co., Ltd., and also of Soil Mechanics, Ltd. ; W. H. G. Roach, managing director, William Press and Son, Ltd., technical director, D. and C. and William Press, Ltd., director of the General Descaling Co., Ltd., and also of John Paul and Co., Ltd., Dublin.

ELECTRONIC INSTRUMENTS AND EQUIPMENT

EXHIBITION IN MANCHESTER

THE seventh annual exhibition of the North-Western Branch of the Institution of Electronics, which was held in the College of Technology, Manchester, during July 15–18, had a record number of exhibitors, more than forty concerns—universities and research associations as well as private firms—being represented. There were, in addition to the trade exhibits, demonstrations of equipment in the research stage and a number of special displays dealing with high-fidelity sound recording and with television. Films on electronic subjects, both elementary and advanced, were shown, and the lecture programme—covering sixteen different topics in all—included talks on technical subjects associated with the special displays as well as discussions of production methods and problems by the staff of some of the exhibiting firms.

In his address at the opening ceremony, Mr. A. J. Philpot, director of research, British Scientific Instruments Research Association, remarked that the development of electronics has been much more closely tied to commercial application than that of most sciences, and the academic treatment has tended to follow rather than precede. This trend has certainly been reflected in these exhibitions. The first five included a succession of striking new applications; but the tendency last year and again this year was towards consolidation—greater reliability, improved efficiency and all the other improvements which go with a better appreciation of the theoretical background. In fact, it would almost be true to say that not one exhibit represented a really new application. This fact probably accounts for the disappointment expressed by some of the lay visitors; a certain familiarity with the field was necessary for the appreciation of some of the improvements offered. None the less there were improvements, some of them quite striking; but as the scale of the exhibition increases it becomes more and more difficult to present an adequate account, and it is more than ever necessary to point out that the items mentioned in this report are simply those which had the strongest personal appeal to the writer.

The Research Laboratory of Associated Electrical Industries, Ltd., demonstrated equipment for measuring infra-red radiation of very low intensity. Normally the minimum measurable intensity is determined by the level of the random noise arising from the lead sulphide detector-cell. In this equipment the incoming signal is chopped by a rotating sector disk and the signal amplified in a narrow-band amplifier. The narrow band is obtained by using the homodyne principle; that is, the incoming signal is mixed with a local signal of the same frequency to produce a beat frequency of zero (namely, a D.C. output). In this way the signal-to-noise ratio is very much increased. The same principle is also being used in the apparatus developed by the Physics Department of the University of Manchester for the detection of very weak light sources (for example, faint stars), which was also on show. In this case the detector is an electron-multiplier cell, cooled in liquid air to reduce the noise-level as much as possible. The best sensitivity so far claimed would allow the detection of 10^{-14} lumens (about 50 quanta of green light per second).

The Department of Electron Physics of the University of Birmingham included in its exhibit an apparatus for producing pulsed magnetic fields of high intensity. Fields of the order of half a million gauss in a volume of a few cubic millimetres can be produced by discharging the energy stored in a condenser through a specially constructed solenoid. In the demonstration a brass washer was hurled several feet into the air by the mutual action of the pulsed field and the field due to eddy currents in the washer. Another application of the sudden discharge of the energy of a charged condenser was included in the apparatus for *Schlieren* spark photography designed by the Fluid Motion Laboratory of the University of Manchester. The condenser is discharged through a simple triggered spark-gap in a circuit of very low inductance to produce a high-intensity flash of very short duration.

In the trade section, the products displayed had a standard of appearance and finish which was very high indeed, and the stands were attractively arranged.

Cinema-Television, Ltd., showed the projector unit and control console of a standard cinema equipment for obtaining a 16 ft. × 20 ft. television picture. The picture from an 8-in. cathode-ray tube is projected by means of a Schmidt optical system. The anode voltage for the tube is 50 kV. and the beam current may rise to 15 mA. A powerful air blast is necessary to prevent over-heating of the screen.

De Havilland Propellers, Ltd., displayed some of their equipment for vibration studies. This included moving-coil vibrators, pick-ups, strain gauges and all the ancillary control and recording gear. The vibrators are like giant moving-coil loudspeaker units with the coil suspended at both ends by a synthetic resin 'spider'. The largest shown was capable of exerting a force of ± 165 lb.-wt.

The familiar, octopus-like mercury-vapour rectifier with six projecting anode tubes can now be replaced by six neat single-anode tubes. These excitrons, displayed by the Rectifier Sub-Station Department of the English Electric Co., Ltd., are air-cooled glass tubes which are provided with control grids. These permit the variation of the output voltage or can be used for arc suppression in conjunction with protective circuits.

The outstanding item on the stand of Ferranti, Ltd., was the transient oscillograph tube. This magnetically focused tube has been specially developed for use in the surge testing of large power-transformers. The fluorescent spot has a high actinic value and, with an $f/1$ lens and normal photographic techniques, clear, full-size negatives of single traces at writing speeds of 30,000 km./sec. can be obtained.

Fielden (Electronics), Ltd., demonstrated a new, servo-operated, self-balancing temperature recorder. The instrument plots the temperature readings for four separate platinum-resistance thermometers in four different coloured inks on the same polar chart. The readings are made in turn at intervals of about five seconds, and a simple but ingenious mechanism

rotates the four-point pen to the appropriate position before each reading is recorded.

At intervals throughout the exhibition, recitals were given on the Gregorian electronic organ, which is manufactured by Alfred E. Davies and Sons, Ltd., and the Acoustical Manufacturing Co., Ltd. This organ was designed to imitate as closely as possible the tone of a good pipe organ. The basic tone generators are valve oscillators. Special attention has been paid to the 'attack' problem, and variable delays can be introduced to simulate the speaking characteristics of various pipes. One of the most attractive features from the organist's point of view is that the tone colour of any particular stop is governed by a plug-in unit. This means that changes in specification or in the precise quality of any particular stop can be made quite simply even after installation is complete.

Among the measuring equipment displayed by Marconi Instruments, Ltd., the moisture meter was of particular interest. The basic circuit is an ingenious modification of the Wheatstone bridge, which makes the instrument independent of valve characteristics and voltage variations. It is designed to give reliable results without laboratory conditions and without demanding special skill on the part of the operator. Interchangeable scales and calibrations are available for a long and fascinating list of materials, ranging from alginic acid through groundnuts to vermicelli (plain and egg). Another interesting item was a universal bridge for measuring resistance, inductance and capacitance which is really direct reading; the figures on the dial change when the range is changed, and the precise units in which the quantity is being measured also appear on the dial.

Twentieth Century Electronics, Ltd., exhibited precision cathode-ray tubes in which the screen face was ground and polished inside and outside. Also on this stand were a bewildering variety of Geiger counter tubes. Interesting members of the series were a sterilizable tube for medical applications and a tube with a mica window so thin that, when delivered by air transport, it has to be sealed in a metal can to prevent explosion arising from the lowering of atmospheric pressure.

The exhibition was obviously the result of much hard work both by the organizing committee and by the exhibitors; but the very large number of visitors must have been a very satisfying reward for those concerned.

C. A. Taylor

DAMPIER: PIRATE AND NATURALIST

By Dr. L. HARRISON MATTHEWS

Director, Zoological Society of London

WILLIAM DAMPIER, the pirate whose tercentenary fell on June 8, is famed as a buccaneer, navigator, diarist and traveller; but his prowess as a naturalist is less well known. His careful descriptions of his travels around the world between 1673 and 1700, which enjoyed considerable popularity in their day and had run into a seventh edition by 1729, contain many accounts of the wild animals that he came across.

In the day-to-day accounts of his voyages there are frequent notes about the birds, fishes, insects and other animals that he saw, often with interesting opinions on their gastronomic value. But it is in his descriptions of the countries he visited and their inhabitants and products that he really excels and provides us with some excellent chapters on natural history.

He made many trips to the Bay of Campeachy, cutting logwood and buccaneering, that is, making boucan, a sort of biltong prepared by sun-drying the flesh of wild cattle, and his account of his journey in 1676 gives many pages to the fauna of the region. The first animal he mentions is the "squash", which appears to be the coati-mondi. It is bigger than a cat, and its head is much like a fox's with short ears and a long nose. "The flesh of it is good, sweet, wholesome Meat. We commonly skin and roast it; and then we call it Pig; and I think it eats as well." He gives a splendid account of the spider monkey, "the ugliest I ever saw. They are much bigger than a Hare and have great Tails about two and a half foot long". When he met a company of them in the woods they defied him by bombarding him with sticks and more offensive ammunition, "chattering and making a terrible Noise; and a great many grim Faces, and shewing Antick Gestures". He gives details of the prehensile tails of these monkeys, and tells how one old male came on to a small branch just over his head and "leaping directly at me made me start back; but the Monkey caught hold of the Bough with the tip of his Tail; and there continued swinging to and fro, and making Mouths at me".

The great ant-eater has a tongue "like an Earth-worm about five or six inches long" with which it licks up ants, and then "puts it out again to trapan more. They smell very strong of Ants, and taste much stronger; for I have eaten of them". The sloth, "a sad coloured Animal", feeds on the leaves of trees, and takes eight or nine minutes to move one of its limbs three inches; "neither will stripes make them mend their pace . . . they seem insensible, and can neither be frightened, or provoked to move faster".

So his descriptions go on, through the mammals, birds, reptiles and fishes, with some interesting bit of acute observation about each, from the large snakes that are "a lazy sort of Creatures" that "lirk in Trees" to the alligator that bit the knee of Daniel the Irishman and left the marks of its teeth in the butt of his gun; poor Daniel "went limping ever after".

Even in those far-off days of the late seventeenth century, Dampier protested against the reckless slaughter of animals for commercial purposes. He was particularly concerned for the introduced cattle that had run wild in the West Indies, and were so important to the buccaneers. "The Spaniards pick and chuse only the Bulls and Old Cows, and leave the young Cattle to breed; by which means they always preserve their stock entire". But the English and French "kill without distinction; yea, the young rather than the old; without regard to keeping up their stock". The seals of the West Indies were similarly exterminated; there may be a few West Indian seals alive to-day, but they are among the rarest of mammals. Dampier relates how a sealing crew was wrecked on the Alcrane Islands "distant from the coast of Jucatan about 25 Leagues; the biggest is not above a Mile or two in Circuit". By great good fortune the sealers were able to fill their casks with seal oil, and refloat their ship at the expense of two New England ketches that ran on the reef, misled by the lights of their fires.

The smaller and more inconspicuous animals did not escape Dampier's notice, for he tells of the two sorts of land crab, the white and the black; "black Crabs are commonly fat and full of Eggs; they are also accounted the better Meat, though both sorts are very good". He also knew *Limulus*, the primitive horse-shoe crab. Near Campeachy "in the Surf of the Sea, close by the shore, you find abundance of Shell-fish, called by the English, Horse Hoofs, because the under part or Belly of the Fish is flat, and somewhat resembling that Figure in shape and Magnitude; but the Back is round like a Turtles; the Shell is thin and brittle, like a Lobsters; with many small Claws: and by report they are very good Meat; but I have never tasted of them myself. . . . Here are also a sort of Spiders of a prodigious size . . . they have two Teeth, or rather Horns an Inch and a half, or two Inches long . . . black as Jet, smooth as Glass, and their small end sharp as a Thorn. These Teeth we often preserve. Some wear them in their Tobacco pouches to prick their Pipes. Others preserve them for Tooth-Pickers".

In the account of his voyage to Australia or "New Holland" in the *Roebuck* in 1699, Dampier gives even fuller details of the natural history, the birds, beasts, and especially the fishes, and also of the plants that he found. He illustrates many of these in copper plates that, considering the times, are remarkably good. Many of the species are quite easily identified from his sketches, and it could well be claimed that he was one of the first traveller-naturalists.

As is only natural, Dampier gives the colours of the birds and other creatures that he saw, and his descriptions are correct; yet one may doubt whether his colour perception was complete. When he was at Tonquin he saw the galleys of the king's navy which were commanded by a general who "was a great Mandarin. . . . There were two more great Officers under him, each in a Vessel by himself. These three had Flags of distinction: the first was yellow, the second blue, the third red or green". Can it be that Dampier was colour-blind, and could not distinguish red from green?

BRITISH MYCOLOGICAL SOCIETY

PLANT PATHOLOGY FIELD DAY

THE twenty-sixth annual plant pathology field day of the British Mycological Society was held on July 4 in the Mycology Section of the Hawthorndale Laboratories, Bracknell, Berkshire, of Imperial Chemical Industries, Ltd. Sixty-six members attended.

Mr. R. V. Tipler, senior mycologist, reviewing the functions of the laboratories, stated that the main task was the evaluation of chemicals produced in the research departments of I.C.I. manufacturing divisions for possible use in controlling crop diseases, pests and wastage caused by bacteria, fungi, insects and eelworms in agriculture, horticulture and industry. The Mycology Section was concerned with prevention or control of plant diseases and crop wastage and with industrial microbiological problems. The demonstrations were arranged to illustrate the scope of the Section's activities in the field of bioassay. They showed the sequence of testing from first-stage sorting by *in vitro* methods for general antifungal and antibacterial activity to second-stage sorting by *in vivo* methods in laboratory, glasshouse and field to discover applications for promising chemicals in industry and as seed, soil and foliage fungicides. Consolidation work, not capable of being shown at the Laboratories, followed under practical conditions at home and overseas with selected materials, under control of the research staff.

Miss M. E. Kennedy demonstrated methods of maintaining the culture collection. In order to reduce subculturing and minimize possible variations in reactions of test fungi to chemicals or pathogenicity to plants the mineral oil and freeze-drying methods of preservation were used. The former was more suitable for mycelial and non-sporing forms and consisted of culture on agar slopes covered to a depth of 1 cm. above the medium with a sterilized mineral oil. In the latter, suspensions of fungal spores or bacteria, with a protective colloid, were dried *in vacuo* from the frozen state. Standard reference cultures had been preserved unchanged in the characteristics under study for more than four years. The Hawthorndale method of inducing profuse sporulation of *Alternaria solani* was demonstrated. Controlled ultra-violet irradiation of mycelial cultures on agar reliably produced spores within eighteen hours. The method had been in regular use for three and a half years.

Mr. J. L. Charlton showed agar plate and spore germination techniques for *in vitro* screening of chemicals. The first method, based on serial dilution of chemicals in an agar medium which was then inoculated with a range of fungi or bacteria, rapidly placed new chemicals in activity categories. Active chemicals were investigated more precisely by the second method, using spores of *Alternaria solani*, *Venturia inæqualis* or *Botrytis allii*. This method was particularly suitable for investigating groups of related chemicals and effect of formulation on antifungal activity. An auxanographic method of demonstrating interactions between effects of chemicals on fungi was on view. Morphological effects of chemicals on germinating spores of *Botrytis allii* were also shown.

Mr. J. N. Turner had on view the miniature kiln test permitting quantitative comparison of chemicals for control of timber sap-stain and moulding, as used for second-stage evaluation of potential industrial fungicides. Notable features were the use of paired surfaces for treatment versus control comparisons and the high degree of replication achieved within a small space. Tests were seen in progress comparing the British Standards and the Pechmann–Schaile methods for laboratory evaluation of timber preservatives. Mycelial mat and soil burial methods for assessing textile preservatives were shown, together with investigations on the effect of leaching and weathering on degree and duration of proofing. Species of fungi responsible for moulding and staining of baled rubber were exhibited.

Miss S. E. Parkinson illustrated with specimens and cultures of the microflora isolated from them the extent and types of damage to leathercloths caused by micro-organisms.

Types of slimes encountered in paper mills were shown, with cultures of bacteria and fungi responsible for their production. Efficiency of control by organomercurial compounds depended, *inter alia*, upon the stock, as its composition affected both the type of slime and the absorption and inactivation of mercury by the pulp. Techniques demonstrating bioassay of active mercury in pulp and white-water included two plate methods using *Cladosporium herbarum* and a turbidimetric method using *Lactobacillus helveticus*.

A sensitivity allowing 0·05 μgm. per gm. of active mercury to be detected was achieved.

Methods of determining the resistance of slime organisms to chemicals were also shown.

Mr. I. W. McC. Callan dealt with tests for evaluating chemicals for use as seed fungicides. Laboratory phytotoxicity tests on wheat supplemented glasshouse disease control trials using oats leaf spot (*Pyrenophora avenæ*) and pea foot rot (*Pythium ultimum*) for determination of disinfectant and protectant properties respectively. Examples of these standardized replicated experiments were seen. In the experiment garden were demonstrations of the application of seed treatments for controlling seed- and soil-borne diseases, particularly seedling rots, of peas, maize, flax, sugar beet, spinach and cucurbits. The extensive 'rod-row' trials which were seen illustrated a replicated block technique based on single rows used for field assay of chemicals for controlling cereal diseases such as wheat bunt and oats and barley smuts.

Machinery for commercial application of dry and wet seed dressings was demonstrated, and in the laboratory an exhibit of a modification of Machacek's agar-sheet technique showed strikingly the extent of variation of load of toxicant on individual seeds obtainable by varying the seed-dressing formulation and the type of machinery used.

Threshing and winnowing equipment developed for accurate estimation of yields from metre-square cereal sampling plots was also shown.

Dr. J. Stubbs had exhibits of a range of plant diseases which were kept in culture and used for glasshouse evaluation of foliage fungicides. These included *Alternaria solani* and *Phytophthora infestans* on tomato, *Uromyces fabæ*, *Botrytis cinerea* and *B. fabæ* on broad bean, *Puccinia antirrhini* on antirrhinum, *Erysiphe graminis* on oat, *E. cichoracearum* on marrow, and *Septoria apii* on celery. The methods of using *A. solani* on tomato for detection and measurement of systemic activity were shown, using griseofulvin as example of an active systemic fungicide. They involved absorption by the plant of chemicals applied to roots or leaves. A 0·05 per cent solution of griseofulvin applied to the soil in which small tomato plants were growing afforded complete protection against disease, whereas the same concentration applied to foliage gave only partial disease control on leaves which had been shielded from the spray.

Mr. J. A. W. Turner dealt in detail with the equipment and methods used in the routine *A. solani* test as developed for the first *in vivo* assessment of potential foliage fungicides and for comparison of effects of formulation (for example, of copper and thiram fungicides) on disease control.

Three tomato plants were sprayed with each of a range of concentrations of a chemical under conditions giving standard deposits. After twenty-four hours drying, plants were inoculated by spraying with *A. solani* spore suspension, incubated at 100 per cent relative humidity for a further twenty-four hours and transferred to the glasshouse. Disease counts were made after three days. ED 50 and ED 95 values were obtained graphically from data from three such tests made at approximately weekly intervals. Thiram was used as standard reference fungicide.

Chemicals active against *A. solani* were then examined further, as required, on the range of diseases demonstrated by Dr. Stubbs, before field evaluation commenced.

Mr. C. E. D. Smith described investigations on the control of *Fusarium* patch of turf, storage diseases of gladiolus corms and narcissus basal rot (*Fusarium bulbigenum*).

Techniques for the bioassay of soil fungicides were shown, based on selective isolation of *Pythium ultimum* and *Thielaviopsis basicola* from soils containing the viable pathogens. These were coupled with further experiments to determine persistence of the chemicals in soil and their phytotoxicity. Successful chemicals were tested against clubroot (*Plasmodiophora brassicæ*) by a rapid laboratory method, and against *Colletotrichum atramentarium* attacking tomatoes. Demonstrations of this last disease included a character for its early diagnosis and a selective method for isolation of the pathogen.

A tour of the eight-acre experiment garden and trials field enabled further aspects of work described in the laboratories to be seen. These included gladiolus corm and narcissus bulb experiments, potato and tomato blight spraying plots and an orchard for investigation of apple, pear and bush fruit diseases.

R. V. Tipler

MELLON INSTITUTE

ANNUAL REPORT FOR 1951–52

THE annual report of the President of the Mellon Institute to the Board of Trustees for the year ended February 29, 1952*, which is published in the *Research Proceedings of the Mellon Institute*, includes a full list of fellowships in operation during March 1,1951–March 1, 1952. Of the Institute's expenditure of 3,835,314 dollars during the year, 727,654 dollars went to the support of investigations in pure science in the Institute's research departments and on nine fellowships, and these projects occupied 117 members of the Institute's staff. In applied science, seventy-seven other fellowships occupied 441 members, and the servicing staff of the Institute numbered 162. New fellowships put into operation during the year are concerned, respectively, with problems of air purification; the development of new chemicals and speciality products, other than fuels and lubricants, used in the operation and maintenance of automobile and aeronautical vehicles and equipment; the technology of glazed and unglazed structural clay products; the combustion of gaseous fuels; the fundamental molecular properties which limit the breaking strength of glass; and the thermostability of active dry yeast.

The Gas Purification Fellowship, which originated in 1939 and was terminated during the year, has led to the development of various new analytical methods, for example, for the rapid determination of hydrogen sulphide and mercaptan sulphur in gases and aqueous solutions, and to a process for reducing the organic sulphur content of coke-oven gas to about 0·5 gm./cu. ft. by scrubbing with an organic base. The Pipe Joint Fellowship, which also has been concluded, has led to the formulation of a product providing adequate thread lubrication during joint make-up and capable of forming a pressure-tight seal in the coupled joints. Other fellowships terminated during the year were the multiple fellowships dealing

* Research Proceedings of the Mellon Institute, 1951–1952 (Annual Report Series No. 39): Annual Report of the President, Edward R. Weidlein, to the Board of Trustees of the Institution for the Fiscal Year ended February 29, 1952. Pp. vi+50. (Pittsburgh, Pa.: Mellon Institute, 1952.)

with the following topics: polymers, in which during the tenure of the fellowship processes have been developed for lattices of styrene polymers and co-polymers; the kinetics and mechanism of the uncatalysed condensation of resorcinol with formaldehyde in various solvents; the efficiencies of light oil recovery and of the operation of Koppers's 'Elex' precipitators for removing suspended matter from coke-oven gas; and tar products, under which extensive studies of the rheological properties of bituminous compounds led to the development of improved industrial pitches, sealing compositions, mastics and protective coatings, and fundamental physico-chemical and rheological studies were made of the nature of coal-tar residual systems.

In the Institute's Department of Research in Chemical Physics a detailed study has been made of the infra-red spectrum of dicyanoacetylene, and its Raman spectrum was being studied. Experimental procedures have been developed for the infra-red study of inorganic salts, and the spectra of a hundred and sixty salts recorded. Emulsion calibration procedures in emission spectroscopy have also been investigated, as well as the fine structures of four reinforcing carbon blacks, with the view of detecting correlations between structure and wear resistance and the crystal structure of solid chlorine. In the Department of Physical Chemistry, four papers on distillation theory have been prepared, and work in this field includes the continued study of the relation between the concepts of the theoretical-plate and transfer units and an indefinite number of components. Much time has been spent on the design of a small automatic digital computing machine. The Department of Physical Measurements is continuously occupied with the determination for publication of the physical properties of compounds the properties of which are inadequately known and of new compounds.

In the Department of Organic Chemistry, the first part of a study in mental disease, involving the concentration of a hyperglycæmic factor from the urine of psychotic individuals, has been completed, confirming the presence of such a factor in the urine of some schizophrenics. In regard to the utilization of carbohydrates in mental diseases and in diabetes, it has been found that reduction of alloxan with excess hydrogen sulphide in acid solution invariably gives rise to dialuric acid and not to alloxantin, but that the latter is produced if exactly half the theoretical amount of the reducing agent is used. Also, in suitably acid aqueous solution (*p*H 1·6), cysteine, glutathione and ascorbic acid have no reducing action on alloxan. A series of 4-hydroxy- and 4-aminopteridines have been submitted for testing as tumour-inhibiting agents at the National Cancer Institute's Laboratory of Chemical Pharmacology.

Of the fellowships in pure science, the annual report refers particularly to those of the Industrial Hygiene Foundation on atmospheric pollution, in which an automatic smoke filter has been developed; on industrial dusts, in which the deposition of inhaled particulate matter in the respiratory tract has been studied; on orthopædic appliances, under which a new method of constructing 'Bunnell' hand splints for stretching contracted fingers has been worked out, foot-plates intensively studied and the relative merits of aluminium and steel for leg traces determined; and on mine-acid control, which point to control of the course of natural ground-water entering the mine as the most effective means. Under the multiple fellowship on synthetic rubber, work has been completed on the infra-red study of polyisoprene, which has been found to be a mixture of *cis-* and *trans-*forms in which the latter predominates at all ordinary temperatures of preparation. Fractionation work in dilute solutions has been completed on a synthetic polyisoprene and on polybutadienes prepared at 5° and 50° C., while the response of solid polymers to oscillating stresses and the ultimate strength of cross-linked rubbers are also being investigated. Under the Fellowship on Artists' Materials an attempt was being made to develop a picture varnish, using a synthetic resin, which will be non-yellowing, flexible and readily removable with mild solvents.

Among the applied science fellowships only a few can be mentioned. Promising results have been obtained under the Meter Technology Fellowship with a non-mechanical device for measuring gas-flow, and in work on sulphur, besides the publishing of revised data on the corrosion of steel by sulphur, a comprehensive study has been made of the metering of liquid brimstone. Developments have been made under the Marble Fellowship of a specification for the use of marbles in indoor and outdoor building construction, and, besides wide research on the effects of heat treatment on the physical properties of optical glass, the Optical Glass Fellowship has been expanded to include in its work the experimental heat treatment of larger pieces of finite geometric shape. Considerable progress is reported under the Ceramic Chemicals Fellowship in knowledge of the relative functions of the various components of enamels and in the control of reflectance, colour, colour stability over large ranges of firing temperature, and resistance to acids and alkalis.

Under the Multiple Fellowship on Acid Recovery a promising process has been developed for treating pickle liquor with raw coke-oven gas, while under that on Chemical Storage an improved method was devised for measuring stresses in large steel structures, which has given information on the stress intensities of various tank members, leading to better designs and economies in the use of scarce materials. Most of the work under the Nickel Fellowship has been directed towards studies of the detergent and other properties of oil-soluble nickel compounds with the object of establishing their suitability as lubricant additives, the wetting properties of nickel sulphide on various catalyst supports, and the effect of conditions of precipitation on the characteristics of nickel hydroxide. A Fellowship on Aromatic Anhydrides has continued to be used for the study of catalysts for the manufacture of phthalic anhydride, and under that on monomers an extensive study was made of catalytic dehydrogenation of alkylbenzenes. Geochemical studies under the Petroleum Fellowship have advanced the synthesis of porphyrin degradation products of chlorophyll and hæmin, while further success has been obtained in the sulphurization of olefins, and studies on Fischer–Tropsch catalysts have shown that primary alcohols can be built into higher hydrocarbons in this synthesis. Basic information on the chemical and physical properties of petrolatum is being accumulated by the Fellowship on Petrolatum, and further studies under the Bread Fellowship support the view that the flavour and aroma of salt-rising bread are due primarily to the acid by-products of a symbiotic fermentation of *Clostridium welchii* and *Clostridium tertium*.

In the research of the Insecticides Fellowship, new methods have been developed for the condensation

of aldehydes with ketones to give the piperonyl insecticides, and under the Felt Fellowship notable progress has been made in the evaluation of cloth filters and the mechanical napping of fabrics. Under the Fellowship on Match Technology researches have begun on improving the resistance of matches to water and high humidity, the selection of binders, etc. During the tenure of the Fellowship on Organic Synthesis new reactions of diketen with the sodium derivatives of pentadione and acetoacetic esters have been discovered, a study of the effects of chemicals on cellulosic and synthetic fibres has been inaugurated and a series of non-ionic surface agents elaborated, the functionality of which in aqueous solution is not greatly affected by temperature, concentration or the presence of polyvalent metal ions and neutral electrolytes; also real progress has been made in 'Vinylite' resin organosol decorative metal finishes. The development of the 'Stypol' resins, a series of liquid thermosetting materials, has continued under the Protected Metals Fellowship, while work of that on Protective Coatings has placed its main emphasis on the development of coatings for military use and the replacement of scarce materials. Two new types of floor coverings, 'Accotred' and 'Vinoflor', were developed under the Cork Fellowship, and research on synthetic paint-brush bristle was a feature of the work of the Special Fibres Fellowship.

PREPARATION AND PUBLICATION OF SCIENTIFIC PAPERS

IT is sometimes customary for scientific societies to give advice and guidance to intending authors as to the preparation of their articles in a form suitable for inclusion in the societies' journals. Usually the advice is limited to some warning about the best method of writing mathematical expressions or to the peculiar layout or spelling adopted by the journal.

A much more comprehensive and instructive manual for intending authors is the revised edition of the booklet "Notes on the Preparation of Contributions to the Institute's Journals and Other Publications" recently issued by the Institute of Physics. The "Notes" were first published in 1931 and were last revised in 1950. No fundamental changes have been made in the new edition; but the opportunity has been taken to make minor corrections and some alterations in acceptable spellings and abbreviations in conformity with recent international and other agreements. Information is given concerning the Institute's publications, the types of contributions acceptable and the conditions of acceptance. Though it is obviously advisable in order to avoid delay in appearance for contributions to conform rigidly with the usages set out in the "Notes", this is not a condition of acceptance.

The "Notes" deal in detail with the preparation, length and cost of text, the form of script and diagrams, the presentation of tabular matter and mathematical expressions and the correction of proofs. Four pages of the booklet are devoted to the proper presentation of circuit, mainly electronic, elements; this seems excessive when it is considered that the Institute's journals do not cater for purely electronic subjects. An interesting reference is to the present average total cost, £10, of each page of text; of a line figure £2 or half-tone £2 10*s.*; of a typical minor change to a line of type once it is set 5*s.*, or of removing a comma 1*s.* 6*d.* This should act as sufficient warning to authors to be extremely careful, to be concise, to avoid unnecessary diagrams and figures and, above all, to revise their manuscripts before submission for publication.

A short bibliography of dictionaries and books on writing scientific and non-technical literature is included in the "Notes", and the detailed appendixes, containing notes and examples of spellings, symbols and abbreviations, the Greek alphabet in Greek and with English equivalents, and printers' marks for correcting proofs, should prove most useful and save authors much valuable time. It is a pity that in what is otherwise an excellent manual there are still a few misprints and that the graphical diagram given on p. 13 to indicate the usual faults made by authors is by no means a clear and good example.

S. Weintroub

DETERMINATION OF PROTEIN CRYSTAL DENSITIES

By Dr. BARBARA W. LOW
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THE accurate measurement of protein crystal densities under a variety of conditions is important for the determination of protein molecular weights by the X-ray diffraction method, and for the study of the composition of these crystals. In order to make best use of the results, it is essential that all the measurements be made on crystals of precisely the same composition. Protein crystals equilibrate rapidly by the loss or gain of water, or by the pene-

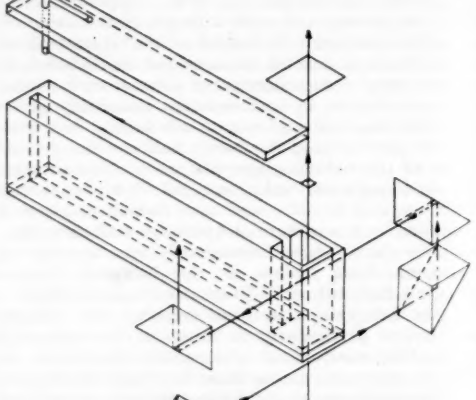

Fig. 1. Schematic diagram of microbalance assembly

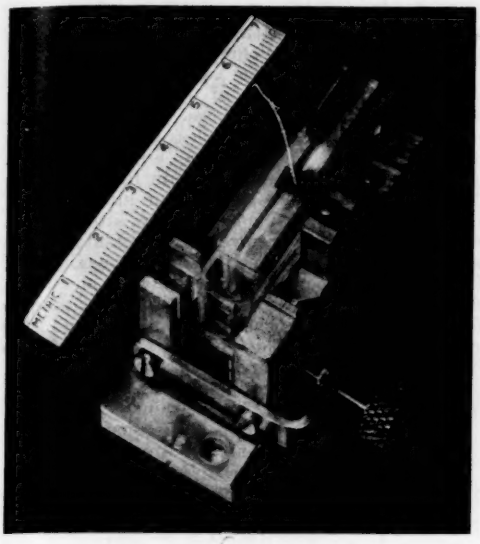

Fig. 2. Perspective view of microbalance

tration of crystal lattices by solute molecules when they are immersed in a media of different composition from that of the mother liquor from which they are grown.

The flotation method developed by McMeekin and Warner[1] for the determination of protein crystal densities and the Linderstrøm-Lang gradient column technique[2] are both capable of accuracies of the order of $\pm$ 0·5 per cent when used with large protein crystals (5–25 mgm.) of simple form, the faces of which may be easily wiped free of mother liquor. Both methods are non-equilibrium procedures—an important limitation when crystals are to be measured which contain both alcohol and water as solvents of crystallization. The alcohol dissolves rapidly in the column, or in the flotation liquid. Suitable immersion liquids in which both alcohol and water are insoluble have not been found.

Following an early suggestion of Prof. J. D. Bernal[3], a microbalance was designed and constructed in order to measure the density of a single protein crystal in equilibrium with its mother liquor. The apparent weight of a crystal, supported on a balance pan while immersed in mother liquor, is recorded as the deflexion of a calibrated fibre. The balance is arranged so that the crystal may be observed in two perpendicular directions and photographs taken of the projected areas. From these areas the volume of a well-formed regular crystal may readily be computed.

The density of the crystal may be calculated from the equation :

$$d(\text{crystal}) = d(\text{solvent}) + \frac{\text{apparent weight of crystal in gm.}}{\text{volume of the crystal in c.c.}}$$

The density of the solvent may be measured by any of the standard methods for liquid densities. The density of protein crystals is usually only 10 or 15 per cent greater than the density of their mother liquor. The correction term in the equation above, therefore, is only approximately 10–15 per cent of the total density. For crystals of simple habit weighing between 1 mgm. and 0·1 mgm. in air, the correction term may be measured with a maximum error of about 7 per cent.

The drawing, Fig. 1, is a schematic diagram of the microbalance assembly. The balance consists of a 'Pyrex' glass fibre firmly fixed at one end and bent into a 1–2 mm. horizontal square at the other end. A polystyrene film covering the square acts as a balance pan. The fibre and glass balance case are supported on a suitable brass frame (Fig. 2), the outside horizontal dimensions of which correspond to an ordinary microscope slide. A set of four $\frac{1}{4}$-in. right-angle prisms are fastened to rotatable mountings permitting accurate alignment for lateral views of a crystal imperfectly aligned on the balance pan. The whole balance assembly is placed on the mechanical stage of a microscope fitted with a 32-mm. metallographic objective, 10 × eyepiece and photomicrographic camera. A net reticule in the eyepiece provides calibration lines on each photograph. The view shown is of a microbalance constructed during the development of the present design. The details of the design, construction and calibration of the microbalance now in use will be described by one of us (F. M. R.) elsewhere.

Fig. 3 shows the photomicrographs from a typical density determination on a crystal of β-lactoglobulin, a preparation used for comparison of this method with other available techniques. The value $1{\cdot}144 \pm 0{\cdot}066$ was obtained with the microbalance, and $1{\cdot}147 \pm 0{\cdot}003$ using the gradient tube method[2] on the same preparation. Measurements indicate that small but real density differences may exist between crystals from different preparations. This could explain the discrepancy between our values and the latest value of McMeekin, Groves and Hipp[4] for β-lactoglobulin ($\rho = 1{\cdot}153 \pm 0{\cdot}002$).

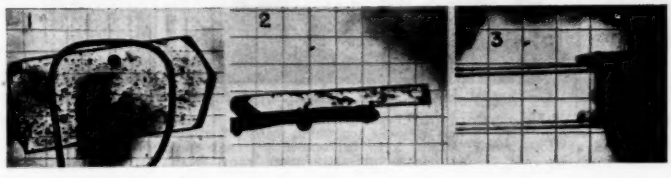

Fig. 3. Photomicrographs for density determination of a crysta of β-lactoglobulin : (1) main face ; (2) end-on view ; (3) deflexion of balance fibre

The microbalance is at present being used in the study of the density of crystals of β-lactoglobulin and of mercaptalbumin mercury dimer[5] in a variety of suspension media. A minor adaptation of the balance, not shown in Fig. 3, permits the immersing fluid to be changed while a given crystal is kept on the balance pan. Simultaneous volume and density changes may thus be observed. Density, composition and X-ray measurements during controlled swelling and shrinking in a variety of media are being made on these crystals as part of a study of protein crystal permeability. [March 5.

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LETTERS TO THE EDITORS

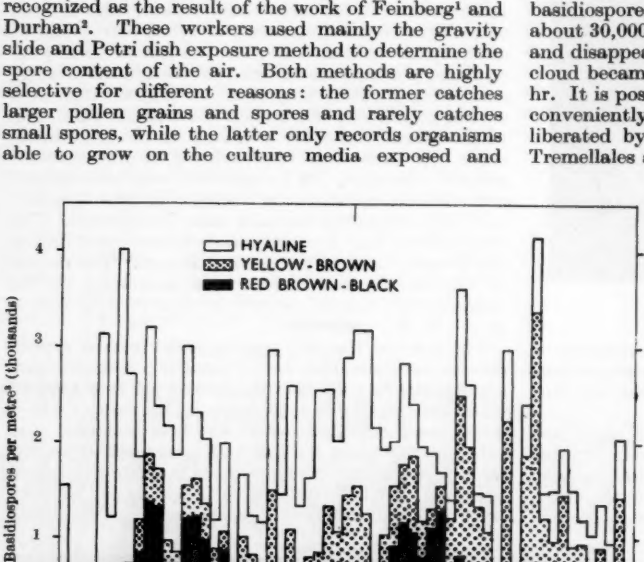
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Possible Role of Basidiospores as Air-borne Allergens

The role of air-borne mould spores in asthma, especially *Alternaria* and *Cladosporium*, has been recognized as the result of the work of Feinberg[1] and Durham[2]. These workers used mainly the gravity slide and Petri dish exposure method to determine the spore content of the air. Both methods are highly selective for different reasons: the former catches larger pollen grains and spores and rarely catches small spores, while the latter only records organisms able to grow on the culture media exposed and therefore selects the more readily growing moulds. Feinberg[1] has stated that basidiospores cause respiratory tract allergy, but data on their occurrence in the atmosphere have been lacking, no doubt because they are not detected by the usual methods.

In studies concerned primarily with fungi pathogenic on crop plants we sampled the air at the height of 2 m. above a potato plot continuously from June 1 to September 30, 1951, using an automatic volumetric spore trap described by Hirst[3]. In this apparatus, which is based on the cascade impactor of May[4], air is drawn through the trap at the rate of 10 litres per minute and the spores are impacted on a 'Vaseline'-coated slide which is moved past a 2-mm. wide slit at 2 mm. per hour. The resulting 24-hr. trace can be scanned under the microscope and the time of deposition of a spore determined with an error of about ± 1 hr. This type of trap is relatively non-selective for particles in the size-range of plant spores, and has been shown to collect and extract from the air not less than 60 per cent of spores as small as those of *Ustilago avenæ* (diam. approx. 6·5 μ). It is therefore reasonably efficient for the size-range of basidiospores, and gives a direct measure of spore concentration per unit volume of air.

The number of hyaline basidiospores fluctuates rapidly. Transient clouds of hyaline basidiospores were observed at various times. For example, on July 22, 1951, after eight rainless days with a high concentration of *Cladosporium* and *Ustilago*, a thunder shower with 2 mm. of rain falling between 13.00 and 15.00 hr. washed the air almost free of pollen and spores. Four or five hours after the rain had fallen a high concentration of minute hyaline basidiospores was observed, reaching a maximum of about 30,000 per metre³ at about 02.00 hr. on July 23, and disappearing almost entirely as the *Cladosporium* cloud became re-established between 05.00 and 08.00 hr. It is possible that these hyaline spores, which are conveniently counted under phase contrast, were liberated by leathery resupinate Agaricales and by Tremellales after wetting by the rain.



Daily mean number of basidiospores per cubic metre of air at 2 metres above ground at Rothamsted, August 1 to September 30, 1951 (data obtained with automatic volumetric spore trap)

The numbers of coloured basidiospores, mainly from Agaricaceæ, were remarkably uniform, and were easily counted on the trace with a high-power dry objective. Their concentration in late summer greatly exceeded pollen concentrations recorded by us in June. From August 9 to September 23 the daily mean concentration of coloured basidiospores seldom fell below 1,000 per metre³ of air (see accompanying illustration). Identification on the trace has not been carried far at present, but spores of species of *Panœolus*, *Hypholoma*, *Bolbitius*, *Ganoderma*, etc., have been observed.

On dry days the basidiospore concentration showed a peculiar diurnal fluctuation, being lowest in the afternoon and increasing by 3–5 times in the early hours of the morning. This contrasts strongly with other spore types studied which have minimum concentrations at night. The fruit bodies liberate spores at a relatively uniform rate and the higher concentration at night may be due to less rapid dilution of the spore cloud owing to wind velocity and turbulence being lower than during the day.

The exposure of the trap in an arable field adjacent to grassland with trees must be representative of vast rural areas in the temperate regions. The steady high concentrations of basidiospores associated with the seasonal flush of agarics and polypores obviously need investigating in connexion with seasonal asthma.

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'Daraprim' Resistance in Experimental Malarial Infections

'DARAPRIM' [2 : 4-diamino-5-(-4'-chlorophenyl)-6-ethyl pyrimidine (50–63)] has been described[1] as having high antimalarial activity in laboratory infections of *Plasmodium gallinaceum*, *Plasmodium berghei* and *Plasmodium cynomolgi*. More recently, it has also been tried in the treatment and suppression of human malaria[2]. It has been shown that proguanil-resistant strains of the first two species are sensitive to 'Daraprim' and that 'Daraprim' resistance is not easily produced in *P. gallinaceum* infections[3].

Since the publication of these experiments, further work has resulted in the production of two strains highly resistant to 'Daraprim': the first, a strain of *P. gallinaceum* in young chicks, and the second, a strain of *P. berghei* in white mice. The *P. gallinaceum* resistant-strain has been previously reported[3] as having only a very slight degree of resistance after fourteen successive passages treated with approximately the minimum effective dose of the drug. Further similar treatment with increasing doses when the previous dose-level proved ineffective has resulted, after forty-two treated passages within a total period of seventy weeks, in a considerable degree of resistance to the drug. The method of infecting and dosing the chicks is similar to that previously described[1].

Using a somewhat different method, a highly resistant strain of *P. berghei* was produced in a much shorter time. The technique, in brief, was to administer to an infected mouse a single dose of the drug when examination of a stained blood film showed 40–50 per cent of the red blood cells to be parasitized; on subsequent relapse after recession of the parasitæmia, the mouse was dosed for a second time and on relapse the strain was passaged. After two further successive mice had received a single dose each in this way, the strain was tested along with the normal untreated parent strain and proved to be more than twenty times less sensitive to the action of 'Daraprim'. Treatment with one more single dose and three drug courses carried out as described by Goodwin[4] has resulted in a very high degree of drug resistance.

The results of some assays of 'Daraprim' on the parent and treated strains of *P. gallinaceum* and *P. berghei* are shown in the accompanying table.

'DARAPRIM' ASSAYS ON NORMAL AND TREATED STRAINS OF *P. gallinaceum* AND *P. berghei*

Exp.	Species	Strain	Minimum effective dose* of 'Daraprim' (mgm./kgm.)	Degree of resistance*
1†	*P. gallinaceum*	Parent Untreated Treated	 0·03 3·8	127
2	*P. berghei*	Parent Untreated Treated	 0·04 >0·8	>20
3	*P. berghei*	Parent Untreated Treated	 0·04 13	325

* As previously defined (ref. 3).
† Exp. 1. After forty-two treated passages. Exp. 2. After four single doses. Exp. 3. After a total of five single doses and three drug courses.

Thus it is seen that 'Daraprim' resistance may arise quite quickly, particularly if the drug is called upon to act on a large population of parasites, as in the development of the resistant strain of *P. berghei*. Where, however, the drug is made to act more as a suppressant, as in the technique used for the development of the resistant strain of *P. gallinaceum*, the initial development of resistance is slow and prolonged.

In human malaria the main use of 'Daraprim' will probably be as a suppressant. As in the case of proguanil, where resistance can easily be induced in the laboratory, the problem of 'Daraprim' resistance in the field is unlikely to become a serious disadvantage to its use.

Full details of these and further observations will be published elsewhere.

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Detection of Digitalis Glycosides on Paper Chromatograms

Neher and Wettstein[1] have used a solution of antimony trichloride in organic solvent to identify certain steroids on paper chromatograms. Although Jaminet[2] has used an acetic anhydride solution of antimony trichloride for the spectrophotometric identification of cardiac glycosides, he has not reported its use with paper chromatograms. Work in this laboratory has shown that antimony trichloride may be successfully applied to this field.

Reagents at present in use for the detection of cardiac glycosides on paper suffer from several disadvantages: the colour produced by *m*-dinitrobenzene is transient and does not distinguish individual glycosides, hydrochloric acid vapour destroys the paper, while with trichloracetic acid the intense fluorescence produced by traces of gitoxigenin completely masks that of other less reactive glycosides. The antimony trichloride in chloroform (Carr–Price reagent) reported here reacts with less than 0·5 μgm./cm.^{2} of glycoside, giving permanent and distinctive colours in visible and ultra-violet light, while the background remains unaffected. Moreover, if stored in an amber-coloured bottle, the reagent keeps indefinitely.

For the chromatographic development, the glycoside solution was applied to the starting line with an 'Agla' micrometer pipette in a spot not more than 0·5 cm. in diameter. The chromatogram was then developed until the solvent front had run 30 cm. (During development the 'spot' had spread until it

Glycoside	Visible light		Ultra-violet light	
	Colour	Sensitivity	Colour	Sensitivity
Digitoxin	Red-mauve, changing to blue-grey	0·75 μgm.	Red	0·25 μgm.
Gitoxin	Mauve, changing to grey	0·75 μgm.	Apple-green	0·25 μgm.
Digitoxigenin	Pale turquoise-blue	1·0 μgm.	Negative	—
Gitoxigenin	Bright orange-yellow	0·75 μgm.	Bright orange	0·25 μgm.

covered an area of about 2 cm.².) The dried chromatogram was treated with a 20 per cent solution of antimony trichloride A.R. in dry, alcohol-free chloroform, and the paper was heated for 3–5 min. at approximately 70° C.

The colours produced are shown in the accompanying table.

On heating, the colour due to gitoxigenin appears first, followed by digitoxin, gitoxin and lastly digitoxigenin, which is also least sensitive to the test. Work in progress indicates that the reagent may be used successfully for the detection of strophanthus glycosides.

I wish to thank the directors of Allen and Hanburys, Ltd., for permission to publish these results.

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March 20.

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Pharmacological and Toxicological Actions of Dart Poison used in Malaya

Pharmacological and toxicological actions of dart poison have received a great deal of attention in the past. Among the contributors on this subject were Ridley[1], Chopra and de Premankur[2] and Doebel *et al.*[3]. It was generally assumed that the chief toxic agent in the dart was the digitalis-like substance contained in the latex of the Upas tree *Antiarias toxicaria*, with which some dart poison was known to be made (Burkill[4], and Chen *et al.*[5]). The present communication puts on record some observations of the pharmacological and toxicological actions of a dart poison obtained recently from the Sakais in Perak, North Malaya. A water extract of the dart poison was prepared by dissolving the poison of one dart in 1 c.c. of water. It was filtered before use for the experiment.

The results obtained showed that the dart poison had no stimulating activity on the isolated guinea pig's ileum. It exerted, however, a strong inhibitory effect on the stimulating action produced by histamine and acetylcholine in the same ileum. In the perfused toad's heart, it had a stimulating effect when given in lower concentration and an inhibiting effect when given in higher concentration. Such effects indicated that the dart poison possibly contained two different substances affecting the toad's heart in opposite directions. In higher concentration, it caused stoppage of cardiac action in diastolic relaxation. This was different, therefore, from the effect produced by higher concentrations of digitalis, which usually results in systolic arrest of the heart. The dart poison lowered the blood pressure and increased both the depth and rate of respiration in cats under 'Dial' anæsthesia. This cardiac inhibitory effect on toad's heart and the lowering of cat's blood pressure were not influenced by atropine, thus showing that the active substance which caused these effects was not a choline ester. It was not thought that the dart poison possessed any antihistamine or atropine-like activity, because its inhibitory effect on histamine and acetylcholine stimulation of the guinea pig's ileum lacked specificity. The dart poison also had some curare-like activity, because it inhibited the contractions of isolated rat's diaphragm elicited by stimulating the phrenic nerve. It was estimated, however, that this activity was weak, because each dart contained the equivalent of only 200 μgm. of *d*-tubocurarine, which is not a toxic dose in small animals.

Toxicological observations made on toads, rats and cats all showed the symptoms of increased respiration followed soon by asphyxia and death. It was concluded that respiratory paralysis was the most likely cause of the fatal results produced by the poison darts in animal hunting. Since it is improbable that one substance should have all the actions listed above, it seems right to conclude further that the dart poison contained more than one pharmacologically active substance and that it had been prepared from several sources of material. The fact, moreover, that the main symptoms were very similar to those produced by strychnine suggested that the chief toxic substance was obtained from a plant belonging to the *Strychnos* group, rather than from the latex of *Antiarias toxicaria*.

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Changes in the Distribution of the Intertidal Barnacles in Relation to the Environment

In previous communications[1,2] the possibility that changes may occur in the distribution of intertidal organisms over a number of years was discussed, and the established distribution of *Chthamalus stellatus* was extended to include much of the Irish Sea coastline. Further new evidence has come to light showing that while this barnacle may have increased its range and abundance over recent years, it was nevertheless present in the Isle of Man in 1933. A photograph taken by H. B. Moore in March 1933 shows a single individual which appears on close inspection to be *Chthamalus*; moreover, statistical tests based on the size and form of the aperture and the angle of the scutotergal margin show that this must be *Chthamalus* and not *Balanus balanoides*.

However, critical observations on *Balanus balanoides* and *Chthamalus stellatus* during recent years have shown a marked change in their distribution, indicating a general recession of *Balanus* from its southern and western limits, and a corresponding increase in *Chthamalus*. Conclusive evidence for this was first obtained by one of us (A. J. S.) by comparison of recent ecological findings for the Plymouth area with those of Moore[3]. This was confirmed and substantiated by records in the Brixham area (D. J. C.), Barnstaple[4] and Isle of Man (A. J. S.). Since the organisms studied are sessile ones, the changes observed are real changes in the population and the possibility of changes due to migration is eliminated. Most of the regions from which *B. balanoides* is disappearing are those where *Chthamalus* is extremely abundant. However, exclusion by direct competition

for rock space is not considered to be the main factor, since available bare rock is usually present in these areas. A second factor might be the recent encroachment of *Elminius modestus*, which has been carefully followed by one of us (D. J. C.) and which settles in the intertidal zone with *B. balanoides* in areas where the species co-exist. But in south Devon, *Elminius* is still found only rarely outside estuaries; yet it is in the regions where *Elminius* is rare, and not in the estuaries, that we find the most clearly marked depletion of *B. balanoides*. A third possibility is the sterilizing effect of the parasite *Hemioniscus balani*, the incidence of which appears to have increased in *B. balanoides* in south Devon, having been higher than 50 per cent in some areas at Plymouth during 1950–51; while on January 7, 1950, at Par (Cornwall), 47 out of 50 individuals were found parasitized (some with double infection). As *Chthamalus* is never infected it is likely that *Elminius*, which is usually infected to about the same degree as *Balanus balanoides*[5], provides a reserve host for the parasite. Thus a high incidence could be established in the normal host (*B. balanoides*) even to the point of extinction, while the rapid breeding of *Elminius*[6] might enable the new host to survive. However, this explanation can be a partial one only, since the recession of *Balanus* appears to be more widespread than either the incidence of *Elminius* or the present abnormally high *Hemioniscus* infection. It is more likely that the high rate of infection by *Hemioniscus* is a further indication of the poor condition of *B. balanoides* in those areas, due to some adverse external change.

Evidence from the south Devon area suggests that it is the planktonic stages which are most vulnerable. Harris[7] states that at Plymouth settlements of *B. balanoides* fail completely during certain years. At Brixham (Torbay) a heavy settlement of *B. balanoides* was recorded in 1946, a moderate one in 1947, and rather poor settlements in 1948, '49, '50 and '51, particularly so in 1951; yet during 1947–50 fertilization of the eggs in late autumn and release of nauplii in early spring took place apparently normally; it was the poor survival of the larval stages which accounted mainly for the failure to replace the normal mortality of the population. A similar occurrence appears to have taken place between 1949 and 1951 in the Isle of Man, where at one locality the numbers of *Balanus* were reduced by as much as 75 per cent; and at the same time the small population of *Chthamalus* increased by up to 50 per cent. Although a proportion of the recent increase in *Chthamalus* may be a secondary result of the decreasing spatfall of *Balanus*, which thus frees more rock for settlement, this cannot be wholly the case in the Isle of Man or in the estuaries of south Devon, since in both places an increase in *Chthamalus* has occurred mainly above the *Balanus* zone.

Taken together, the changes in distribution of *Balanus* and *Chthamalus* suggest the influence of some general climatic factor, such as the recent succession of mild winters or a rise in average temperatures during several years. It is difficult to envisage other factors operating so generally and yet capable of affecting both species. The mode of action need not necessarily be a direct or obvious one; it might, for example, cause abnormalities in the early embryonic development of *Balanus* and render many of the larvæ ultimately non-viable; it might also result from changes in the phytoplankton succession[8]. An understanding of the mechanisms by which such changes operate is clearly of great importance, since if they are climatic in origin, as we suggest, they would be expected to have an influence on many other marine organisms, including probably some of economic value.

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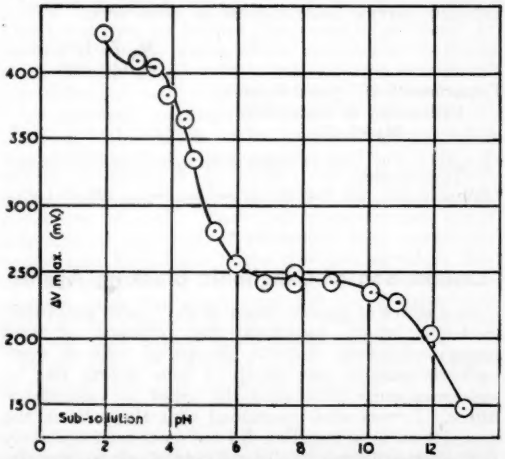
Ionization of Bovine Serum Albumin Monolayers

It has long been known that the surface electrical potential of a protein monolayer at the air/water interface is dependent on the *p*H and the nature of the ions present in the aqueous sub-solution. There is no record, however, of a comprehensive investigation of the variation of protein surface potential with the *p*H of the sub-solution. This information, were it available, would be a 'titration curve' of a protein monolayer, and would shed light on the nature and extent of the ionizing groups of the protein when spread as an insoluble monolayer. We wish to report preliminary results of such a surface titration curve for the protein bovine serum albumin.

The accompanying graph shows the surface potential of a bovine serum albumin monolayer as a function of the *p*H of the aqueous sub-solution. This solution contained 0·01 *N* sodium chloride and was buffered by 0·005 *M* ($H_2CO_3/NaHCO_3/Na_2CO_3$). The presence of sodium chloride ensured a stable insoluble monolayer, in addition to minimizing any ionic charge effects due to the ionizing buffer salts over the *p*H range 2·0–13·0.



Surface titration curve of insoluble monolayers of bovine serum albumin, spread on 0·005 *M* bicarbonate buffer containing 0·01 *N* sodium chloride

The technique adopted was as follows: 'Armour' crystallized serum albumin (10·0 mgm.) was dissolved in, and spread from, distilled water (20·0 ml.) containing 1 per cent ethanol. Simultaneous surface pressure and surface potential *v.* area measurements were made, using standard compression isotherm procedure for insoluble monolayers. For a given subsolution, the surface potential varied with the state of compression of the monolayer. At the collapse point, however, the surface potential became constant and attained its maximum value. This maximum value (ΔV max.) was taken as characteristic for the protein monolayer under the appropriate conditions of *p*H and ionic strength of the subsolution. Surface potentials were reproducible to ± 5 mV.

From the graph it can be seen that appreciable changes in surface potential (ΔV max.) occur in the *p*H ranges 3·5–6·5 and 10·0–13·0. The former change is clearly due to the ionization of carboxyl groups, whereas the latter change is due to the neutralization of the cationic amino groups of the protein. The general shape of the curve is similar to that obtained by acid-base titration of the native globular protein dissolved in aqueous solution. Some differences are evident, however. For example, we note that, compared with results obtained in bulk solution[1], the curve is markedly displaced towards higher *p*H values, thereby raising the apparent pK_a values of the dissociating groups. Such a result has already been observed with monolayers of long-chain fatty acid[2]. Furthermore, it appears that the neutralization of the iminazole $=\overset{+}{N}H-$ group of histidine is not being shown by changes in surface potential. The reason for this is not yet clear. However, it may very well be that these amino groups are not available in the surface when the protein monolayer is highly compressed.

The great advantage of the present technique is that it permits the study of the ionization of a protein which is only available in small amounts, 10 mgm. being ample for such an investigation. Further work on other proteins and high-molecular weight polypeptides is being actively pursued and will be discussed elsewhere in due course.

Our thanks are due to Dr. J. H. Schulman for valuable advice and interest in this work.

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Comparison of Ganglionic Blocking Agents

In a series of papers, Shaw *et al.*[1–3] have submitted evidence which indicates the presence of two pharmacologically distinct groups of cells in sympathetic ganglia, one group of cells giving rise to vasoconstrictor fibres and the other to vasodilator fibres. It was also mentioned that the cells in the superior cervical ganglion did not react quantitatively in the same manner to all paralysants[3]. Consequently, a number of ganglionic blocking agents have been tested on the superior cervical ganglion of cats.

A condenser-type strain gauge was used to record the contraction (and relaxation) of the nictitating membrane, and a photoelectric method was used to record the constriction (and dilatation) of the blood vessels in the ear. A test stimulus of constant repetition-rate, for a fixed time, was applied to the preganglionic fibres. This stimulation of the cervical sympathetic trunk resulted in contraction and constriction of the nictitating membrane and ear vessels respectively. All paralysants were administered by direct injection into the common carotid artery, the blood supply of the ganglion being left intact.

Two series of measurements were made for all drugs: (*a*) the duration of complete paralysis of the nictitating membrane and of the ear vessels; (*b*) the time to complete recovery of these two test objects.

In general, we have found that after paralysis the responses differ, in that the time taken by the nictitating membrane to show a first response differs from the time taken by the ear vessels.

	Duration of paralysis (min.)		Duration to complete recovery (min.)	
	Ear vessels	Nictitating membrane	Ear vessels	Nictitating membrane
D-Tubocurarine chloride 0·2 mgm./kgm.	22	10½	30½	29½
Dimethyl tubocurarine iodide 0·3 mgm./kgm.	12½	3½	30	12
Pentamethonium iodide 3·5 mgm./kgm. (C5)	5	11	31	39
Tetraethyl ammonium bromide 7 mgm./kgm.	7	13½	10	25½
(T.E.A.B.) 'Pendiomide' 2 mgm./kgm.	8	8½	16	16

The accompanying table shows the averaged times from about six experiments for each paralysant. For D-tubocurarine and dimethyl tubocurarine, the ear vessel response is more affected than is the nictitating membrane, the reverse result being the case for pentamethonium iodide and tetraethyl ammonium bromide. In the case of N,N,N′,N′-3-pentamethyl-N,N′-diethyl-3-aza-pentane-1,5-diammonium dibromide (CIBA 9295, 'pendiomide')[4] there is practically no difference. Although differences are apparent in the times to complete recovery, they are not as marked as the paralysis times.

Whether the differential response obtained is due to the blocking agents acting at the ganglion, or peripherally, or at both these sites, we cannot as yet say. Stimulation of the post-ganglionic fibres from the superior cervical ganglion while the ganglion is still paralysed will be carried out to give an indication as to where the paralysants are causing the differential effect. Guyton and Reeder[5], and also Paton and Zaimis[6], have shown that different ganglia vary in sensitivity to a particular blocking agent. So far as we know, both the ear vessels and the nictitating membrane are innervated directly from the superior cervical ganglion, that is, only one ganglion is involved; therefore it is unlikely that the differential results obtained can be explained on the basis of ganglion sensitivities.

It appears that the response of the nictitating membrane itself does not give a precise account of the action of the various ganglionic blocking agents used. When testing an agent for paralytic activity on ganglion transmission, it may not be sufficient

to employ only one test object. As animal experiments are usually carried out prior to clinical testing, it would be best if tests for ganglionic paralysants resembled more the purpose for which they were used in man, namely, to prevent vasoconstriction resulting from active vasoconstrictor fibres.

The neuromuscular blocking agent tri-(diethylaminoethoxy)-1,2,3,benzene triethiodide (gallamine triethiodide—'flaxedil') was also administered and, as expected, failed to block the ganglion except in very large doses. However, in about 40 per cent of the experiments it brought about a potentiation of the ear vessel constriction on stimulation and had very little effect on the nictitating membrane response (dose, 7 mgm./kgm.). As Mushin *et al.*[7] have found that 'flaxedil' does not possess anti-choline esterase activity, the potentiation cannot be explained on these grounds. As yet we have no explanation for the result.

2,5-*bis*-(3-Diethylaminopropylamino)benzoquinone-*bis*-benzyl chloride (WIN 2747) has been shown by Hoppe[8] to be a neuromuscular blocking agent. As in the case of 'flaxedil', it failed to block the superior cervical ganglion except in large doses. A marked reduction of the nictitating membrane contraction was found to occur with doses of 3 mgm./kgm., when the pre-ganglionic fibres were stimulated. At the same time, this dose of WIN 2747 was found to have very little effect on the ear vessel constriction.

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Molecular Weight of Glycogens determined by a Light-scattering Method

The use of light-scattering methods for the determination of the molecular weight, size and shape of macromolecules has become of increased importance in recent years. Studies already made include those on cellulose acetates[1], polystyrene and synthetic polymers[2], and several proteins[3,4]. The influence of sodium chloride on the size and shape of a detergent–protein complex has recently been investigated using a light-scattering method[5]. The application of this method to the measurement of the molecular weight of several glycogens is reported in this communication.

The relation between the molecular weight M, of the solute, and the turbidity τ, of the solution, is given by the well-known equation[6,7]

$$\frac{H.C}{\tau} = \frac{1}{M} + 2B.C, \qquad (1)$$

where C is the concentration of the solute in gm./ml., and H and B are constants.

The glycogens examined were supplied by Dr. D. J. Bell, and had unit-chain lengths of 11–13 glucose radicals (determined by potassium periodate oxidation[9]). The light-scattering apparatus used has already been described[5]. It was calibrated in terms of bovine serum albumin, a molecular weight of 69,000 being assumed for this protein[4]. Refractive index increments were determined using a Rayleigh type interferometer. Curves of $H.C/\tau$ *v.* C for the various glycogens are shown in the graph, and the molecular weights, calculated by extrapolating these curves to zero concentration, are given in the accompanying table.

Source of glycogen	M	I_{50}/I_{130}
Rabbit liver	$6{\cdot}8 \times 10^6$	1·15
Rabbit muscle	2·8 „	1·0
Cat liver	10·0 „	1·40
Fœtal sheep liver	14·8 „	1·10
Tetrahymena pyriformis (ref. 9)	9·8 „	1·90
Ascaris lumbricoides	8·8 „	1·17

Considerable diversity is found among the results of different workers for the molecular weights of various glycogens[10]. The results for rabbit muscle and *Ascaris* glycogen may be compared with those obtained by Bell *et al.*[11] on the same samples of glycogen, from sedimentation-diffusion measurements. The present value of $2{\cdot}8 \times 10^6$ for rabbit muscle glycogen agrees well with their value of $2{\cdot}6 \times 10^6$. There is a marked disparity between the value of $8{\cdot}8 \times 10^6$ for *Ascaris* glycogen and the value of $0{\cdot}7 \times 10^6$ obtained by Bell *et al.* However, examination of their sedimentation diagram for *Ascaris* shows considerable broadening of the 'peak' in the direction of higher molecular weight units. Since molecular weights calculated from turbidity data are 'weight average' values, the presence of small amounts of material of high molecular weight will result in the values obtained by this method being much higher than the molecular weight of the main fraction of the sample.

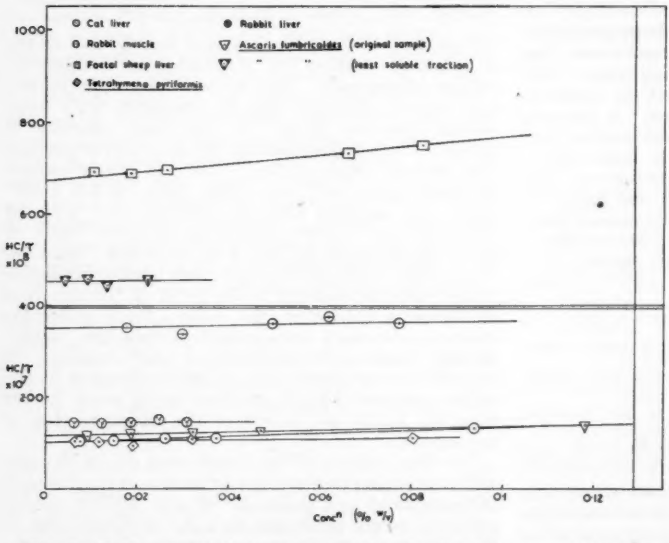
The dissymmetry of light-scattering shown by some of the glycogens (see table) may be due to the presence of fractions of high molecular weight. Rabbit muscle glycogen, which gives the most symmetrical peak in the sedimentation diagram[11], shows no dissymmetry; furthermore, fœtal sheep liver glycogen, which has the highest molecular weight of any glycogen reported in the table, shows a negligible dissymmetry. This point may be further illustrated by reference to *Ascaris* glycogen, which shows a disparity between the molecular weight values obtained from sedimentation-diffusion and light-scattering measurements. This glycogen originally showed a dissymmetry (I_{50}/I_{130}) of 1·15–1·20. After fractional precipitation with ethanol at a concentration of 40 per cent, a fraction (3 per cent by weight) was obtained which had a molecular weight of $22{\cdot}5 \times 10^6$, and a dissymmetry of 1·45. This clearly shows that small amounts of material of relatively high molecular weight may be present in the glycogen samples. For this reason, none of the values given in the accompanying table has been corrected for dissymmetry and must be regarded as giving an order of magnitude only for such highly polydisperse systems.

H. Staudinger[12] has measured the molecular weight of various glycogens using the relation:

$$K_L.M = \tau_{sp}, \qquad (2)$$

where K_L is a constant for the wave-length used and τ_{sp} is the specific turbidity (that is, the absolute turbidity of a solution containing 1 gm. solute per

litre). This equation is equivalent to equation (1), if there is no deviation from the van't Hoff osmotic pressure law, that is, if $B = 0$. Staudinger determined K_L from the turbidity of samples of glycogen the 'molecular weights' of which had been determined by osmotic pressure measurements. His values for rabbit liver, rabbit muscle and cat liver glycogens of $5{\cdot}2 \times 10^6$, $1{\cdot}9 \times 10^6$ and $6{\cdot}9 \times 10^6$ respectively are considerably lower than the values reported in our table. It must be noted, however, that the samples of guinea pig liver glycogen used by Staudinger for calibration were likely to be polydisperse. Since osmotic pressure measurements give 'number-average' molecular weights, the values obtained in terms of this standard would tend to be lower than the 'weight average' values normally given by turbidity measurements.



We thank Dr. J. H. Schulman and Dr. D. J. Bell for advice and helpful discussions, and Dr. J. F. Ryley for the sample of *Tetrahymena pyriformis* glycogen. One of us (B. S. H.) is indebted to the Consolidated Zinc Corporation, Ltd., for the award of a research grant. The other (D. J. M.) acknowledges the award of a research studentship from the Agricultural Research Council.

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Effect of Withdrawal-Rate on Second Explosion Limits

In a recent communication, Baldwin and Precious[1] have directed attention to the effect of withdrawal-rate on the hydrogen–oxygen second limit. Since they found this effect to be present in clean vessels and absent in vessels coated with potassium chloride, they favour an explanation which connects it with the participation of quadratic branching in the reaction. During our examination of the hydrogen–oxygen reaction[2], we have also had occasion to study this phenomenon. Our own observations suggest that the effect is not directly connected with the presence of quadratic branching and support the alternative explanation, namely, that the net branching factor is reduced to zero by the products formed during the initial stages of the explosion.

While agreeing that the effect is most pronounced in vessels of low chain-destroying efficiency (clean 'Pyrex', boric oxide) we have also observed it with many other surfaces (potassium chloride, potassium hydroxide, etc.) at higher temperatures where the slow reaction is of the same order, but where significant quadratic branching is still not detectable. The effect is negligible in very rich mixtures and increases markedly as the hydrogen–oxygen ratio decreases, thus becoming greatest in the region where the slow reaction and quadratic branching contribution are at a minimum. We have also found a similar phenomenon to occur in carbon monoxide–oxygen explosions, but have not been able to find any indications of quadratic branching in this reaction.

This alternative explanation is supported by the work of Von Elbe and Lewis[3], who showed that the transition from slow reaction to explosion is not a true discontinuity, and that it is possible for the water formed in the initial stages of the explosion to suppress completely its subsequent development. (Incidentally, those observations were made in a 'potassium chloride' vessel under conditions where quadratic branching is not evident.) From the experimental curve of Baldwin and Precious, one can visualize a condition in which the net branching factor is being decreased by the production of water at the same rate as it is being increased by the slow reduction of pressure. Such a system would stay on the brink of explosion right through the explosion region without suffering anything more than a vigorous slow reaction.

Two observations confirm this view. In the hydrogen–oxygen reaction it was noticed that if the withdrawal-rate was made so slow that the mixture would not normally explode, and if at any time after crossing the limit the evacuation-rate was increased by a sudden twist of the tap, then explosion followed within a period of $\frac{1}{2}$–3 sec. Secondly, with moist carbon monoxide–oxygen, one is fortunate in being able to 'see' the presence of a slow reaction by the blue glow emitted. On crossing the limit at a fast rate, the blue glow suddenly increases to a brilliant uncontrollable flash; but with sufficiently

slow evacuation no such transition occurs, the blue glow rising to a constant value throughout the explosion region. If evacuation is stopped at any stage after crossing the limit, the blue glow slowly fades. A further slight evacuation brightens it up momentarily, and this process can be repeated many times.

The phenomenon leads to experimental difficulties only when observing the second limits of very weak mixtures. To obtain any explosion at all in this region, the rate of evacuation must be faster than is desirable for accurate manometer reading, and also under these conditions the explosion lag, as indicated above, must become a significant source of error. This uncertainty tends to prevent the accurate determination of the constants c and F of the explosion limit equation[2], values from the second limit being much greater than those derived from the first. Furthermore, the unknown error due to explosion lag might well be the cause of the observed but unexpected temperature dependence of the third-body coefficient a^2, since the necessary rate of withdrawal increases both with ratio of oxygen to hydrogen and with temperature.

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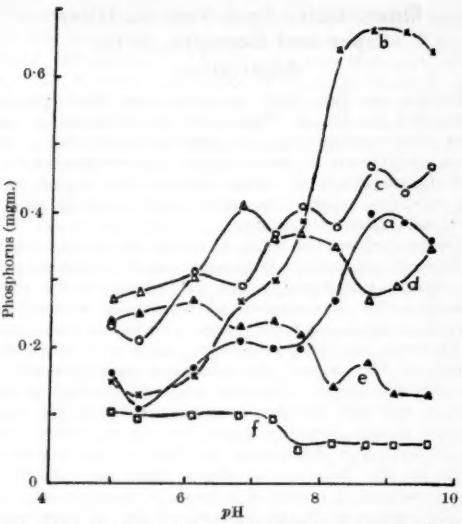
Zinc, Ionic Equilibrium and Phosphatase Activity

Controversy has centred around the nature of the active groups influencing the activity of alkaline phosphatases of higher animals[1]. In a recent communication[2], I suggested on the basis of results obtained with the alkaline phosphatase of the fungus *Penicillium chrysogenum*, Q-176, that the activity of the enzyme is influenced by both zinc and magnesium ions and that the relative proportion in which these ions existed in an active state determined the pH of optimum activity.

I have further investigated this problem with alkaline phosphatases prepared from ox kidney and intestines by the method described by Thoai, Roche and Roger[3], and the results obtained by me go to support my earlier observations that both zinc and magnesium ions and the relative concentration in which they are present exert considerable influence on the activity of the enzyme. From the accompanying graph, it will be apparent that while cyanide at higher concentrations inhibits activity at all the pH's tested, the enzyme shows increased activity on the acid side at intermediate concentrations of cyanide and on the alkaline side at very low concentrations. I have also observed that by the addition of magnesium ions to the enzyme inhibited by 0·002–0·004M cyanide, activity was increased on the acid side to a considerably greater extent than at other pH's, whereas a similar addition of zinc resulted in the restoration of activity at all the pH's at low, and on the alkaline side at intermediate, concentrations of zinc. In



Effect of varying concentrations of cyanide on ox kidney alkaline phosphatase at different pH's. Each substrate contained neutralized sodium cyanide at the following concentrations: (*a*) nil, (*b*) 0·0002 *M*, (*c*) 0·0004 *M*, (*d*) 0·001 *M*, (*e*) 0·002 *M*, (*f*) 0·004 *M*

both cases there was an optimum concentration at which the activity was maximum, higher concentrations of zinc especially bringing about general inhibition of activity at all pH's.

The complete inhibition of activity of the enzyme at all the pH's on the addition of cyanide at the higher concentrations and the effect of addition of zinc in increasing concentrations to the cyanide-inhibited enzyme in restoring the activity first at all the pH's and thereafter at the more alkaline pH's show that zinc ions are necessary for activity at alkaline and acid pH's. Other heavy metals, such as manganese, iron or cobalt, had no appreciable effect in restoring the activity of the cyanide-inhibited enzyme. It is well known that magnesium ions are necessary for full activity of the enzyme on the alkaline side, and I have observed that this is so only when zinc ions are also present, for the cyanide-inhibited enzyme is only partially activated by magnesium on the alkaline side.

From these findings, I suggest that there is no entity like 'acid' or 'alkaline' phosphatases, but that by merely changing the equilibrium between the prosthetic ions or groups of the enzyme, activity can be established at any pH desired. Admittedly, the phenomenon as it applies to enzymes in higher animals is more complex than the one observed for the enzyme in *P. chrysogenum*, Q-176. The results of this investigation will be published in due course.

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Quantitative Spot Test on Filter Paper and Examples of its Application

While, so far, the spot test on filter paper, developed by Dr. F. Feigl and his co-workers, has been used exclusively for qualitative purposes, we have discovered a method for the estimation of various substances by using circular filter papers and the solvents which are commonly used in paper partition chromatography.

The procedure is as follows. At the centre of a circular filter paper a small drop is placed of the solution of the sample containing a few milligrams of the substances under examination. After drying, solvent for partition chromatography is dropped in small portions (5–10 drops per min.) from a capillary tube on to the centre of the paper, thus causing development of the chromatogram. The substances contained in the sample mixture develop gradually to accurate concentric circles forming partition zones. For this manipulation a desiccator or Wit's filter bottle is used, in the bottom of which there are placed a small volume of partition solvent to saturate the air in the vessel with the vapour of the solvent used and a Petri dish containing the same solvent on which the filter paper (of about 11 cm. diameter) is placed. The development is complete when solvent has spread to a circle 7–8 cm. in diameter (about 30–40 min.). By using circular filter paper, we can work with much larger amounts of material in a shorter time than by the usual method of paper chromatography. Quantitative estimation is usually made by calculating the area of partition zones on the filter paper. It may, however, be effected, in general, more exactly by cutting up the paper, extracting and then applying colorimetry or densitometry by ultra-violet light to the extract. The chromatograms thus obtained are similar to those produced by Rutter's method[2]. Our procedure was developed in the past few years independently of his report.

The following are a few examples of the application of quantitative spot tests on filter paper.

(1) *Estimation of methanol and ethanol.* In a preceding paper[3], we reported a method for the detection of methanol, in which the potassium xanthogenates derived from a methanol–ethanol mixture by adding carbon disulphide and potassium hydroxide are submitted to paper partition chromatography using butanol saturated with 5 per cent sodium bicarbonate solution. Applying the technique outlined above, the ethyl xanthogenate is discernible as an outer circle, while that of methanol is located in an inner zone, as shown by ultra-violet light. The chromatogram is dried, cut up into its partition zones and the latter extracted by 5 per cent sodium bicarbonate. After sixty seconds from the addition of freshly prepared Grote's reagent (twice normal concentration) the estimation can be made electrophotometrically.

(2) *Estimation of R-acid and G-acid.* Both acids are apt to be produced in admixture as intermediates in the manufacture of dyes, and their separation was considered hitherto as a difficult problem. Applying our new technique to the development of the mixture of both acids (using butanol saturated with a 5 per cent solution of sodium bicarbonate) and following the process under ultra-violet light, the partition zones (outlined with pencil) are extracted with 5 per cent sodium bicarbonate solution. By addition of the diazonium salt of naphthionic acid, there are produced red dyes, which can be estimated electrophotometrically.

Note added in proof. A somewhat similar technique of circular paper chromatography has been described recently by Giri and Rao[4].

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Conductance in Non-aqueous Solutions

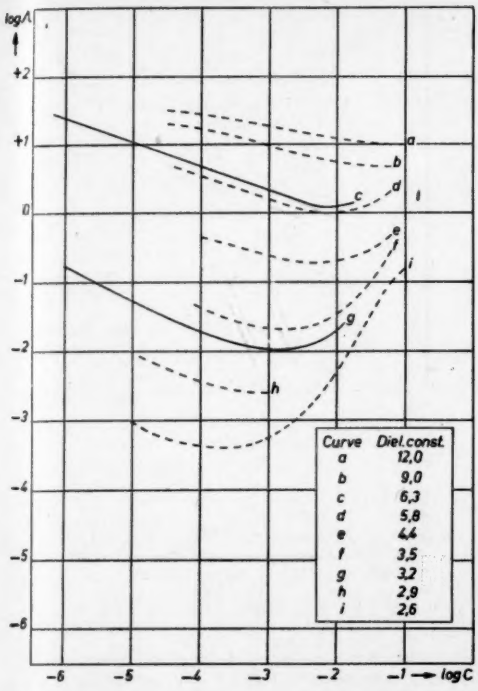
In the extensive work of Fuoss, Kraus and co-workers[1] on the conductivity of solutions in media of widely divergent properties, these authors are led to the conclusion that, viscosity excepted, there is no specific influence due to the solvent, but that the dielectric constant of the medium alone determines conductivity data.

Since Fuoss and Kraus do not consider acid media, measurements of conductance of solutions in some organic acids are in progress in this laboratory to test the theory mentioned above. The following materials were used: 100 per cent glacial acetic acid (solvent-conductance $0{\cdot}4–0{\cdot}8 \times 10^{-8}$ mhos) obtained by fractionating 97 per cent acetic acid; 100 per cent propionic acid (solvent-conductance less than 3×10^{-10} mhos) obtained by fractionating a C.P. product; tetraethylammoniumpicrate (melting point 255·5° C.) prepared from silver picrate and tetraethylammoniumiodide. The conductance was measured with a Jones bridge[2]; a cathode-ray oscilloscope served as detector of current-minimum. A frequency of 1,000 c./s. was used. The conductance cells were designed according to Jones and Bollinger[3], using non-platinized platinum electrodes. The measurements here described were made with a 125-c.c. cell (cell constant 0·00965). In preparing the solutions, all precautions were taken to prevent contact with the air.

Measurements were carried out at 25° C. with solutions of tetraethylammoniumpicrate in glacial acetic acid ($D = 6{\cdot}25$) and propionic acid ($D = 3{\cdot}15$) respectively, covering a wide range of concentrations. The accompanying graph shows the logarithm of the equivalent conductance (Λ) as a function of log molality (C). The dotted lines are from data of Fuoss and Kraus[1] on tetra*iso*amylammoniumnitrate in mixtures of dioxane and water.

Although Fuoss and Kraus worked with a somewhat different salt (both salts, however, are rather strong electrolytes), it is obvious that our values fit in very well with theirs. So we may conclude that, also in the acid media, the dielectric constant is the determining factor for the conductance phenomena.

With the aid of the extrapolation method of Shedlowsky[4] the following constants, corrected for solvent conductance, can be given for tetraethylammoniumpicrate in acetic acid: Λ_0 (equiv. conduct.



at infinite dilution) = 29·9 ohm^{-1} cm.^{2}. K (dissociation constant) = $1{\cdot}63 \times 10^{-6}$.

The values for propionic acid cannot yet be given. This work is being carried out with solutions of different electrolytes in formic acid (D = 58), acetic acid, propionic acid and mixtures of these solvents.

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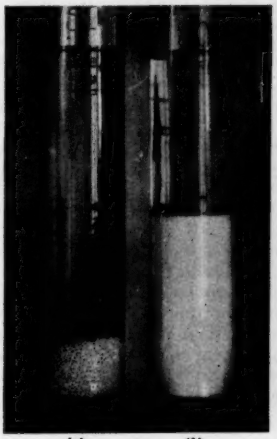
Micro-spherical Aggregation of Barium Sulphate

During an investigation of the influence of certain organometallic compounds on the velocity of sedimentation of inorganic materials in non-aqueous media, a phenomenon has been observed which does not appear to have been previously recorded. Precipitated barium sulphate, free from soluble salts, as prepared for X-ray examinations, and containing no addition agent, was dried for several days at 110° C., and shaken with pure dry benzene in a stoppered Nessler tube in an automatic shaker. The shaking was carried out at the rate of five oscillations per second, the tube being shaken longitudinally, with a displacement of 2 in. After 24 hr. the solid had aggregated completely into spheres of 1–0·5 mm. in diameter, as shown in Fig. 1(*a*). The sediment volume was slightly less than that of the lightly tamped dry solid, indicating a close degree of packing of the spheres. If the tube was then subjected to very violent and irregular manual shaking, the spheres broke up to form a flocculate (shown, after 24 hr. standing, in Fig. 2). On further regular shaking for 30 min., the spheres re-formed as before.

It is tentatively suggested that this phenomenon may be due to the fact that barium sulphate has a hydrophilic surface (method of Davis and Curtis[1]), and that it will consequently tend to aggregate so as to present to the benzene the minimum surface per unit volume. In this respect the phenomenon can be regarded as in some way analogous to the formation of drops of one liquid when shaken in another. It is to be expected that this form of aggregation would not occur in a solvent which is miscible with water, so the experiment was repeated with 1 : 4 dioxan. The suspension formed was very fine, and settled very slowly (about 4 cm. per hr.); Fig. 1(*b*) shows its appearance after standing for three days. Even after prolonged shaking, no sphere-formation was observed. In diethyl ether, however, the barium sulphate formed spheres, though somewhat larger and more easily broken up than those from the benzene suspension.



(*a*) (*b*)
Fig. 1

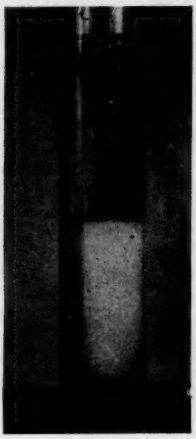


Fig. 2

In each of the tubes (Figs. 1 and 2), which were of equal diameter, the total volume of solid and liquid was 50 ml., and the weight of barium sulphate was 10·00 gm.

A further experiment was carried out, using basic lead carbonate, which is known to have an 'organophilic' surface[2]. On shaking this with benzene there was, as might be expected, no sign of sphere-formation.

This work is being continued, and will be reported in detail elsewhere.

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Gravity Observations in a Borehole

Gravity surveys are widely used as a method of geophysical exploration. A knowledge of the densities of the underlying rock layers is necessary for the interpretation of the results. While the density of samples may be determined in the laboratory, the only really satisfactory method of finding the bulk density is by gravity observations in a mineshaft or a borehole. The information obtainable by this method has been discussed by Smith[1], who has also suggested further uses for the observations.

With this object in view, a gravimeter has been constructed and some preliminary tests have been made in an oil borehole belonging to the Anglo-Iranian Oil Co. at Eakring, Notts. The gravimeter is similar in principle to that previously described by me[2], but various points in the design have been improved and modified to suit the limited space available in a borehole.

Fundamentally, the instrument consists of a thin filament held in tension by a weight; the transverse vibrations of the filament control the frequency of an electronic oscillator. The weight is prevented from rotating about an axis along the filament by means of thin strip hinges and, between observations, may be held in its normal position by a system of clamps operated by an electric motor. The instrument and the thermostat which controls its temperature are mounted in gimbals inside a pressure-tight steel container, which also contains electronic apparatus for maintaining the oscillations of the filament and operating the thermostat. The external dimensions of the container are 5 in. external diameter by 8 ft. in length. The apparatus for recording the frequency of vibration of the filament is at the surface, and is electrically connected to the gravimeter by the 4-core cable which supports the instrument in the borehole.

The vertical gradient of gravity may have three main component parts, assuming that the rock layers penetrated are uniform, horizontal and of large lateral extent. The first is the normal free-air gradient; the second component, of magnitude $4\pi G\rho h$, is due to the attraction of the rock layer penetrated, h being its thickness, ρ its density and G the gravitational constant. The third component, which may not be present, is the gradient due to a buried anomalous mass. The presence of such a mass may usually be inferred from a surface gravity survey around the borehole, or from the abnormal vertical gravity gradient near the mass. The numerical values of the free-air term of the vertical gradient is 9·41 milligals per 100 ft.; the second term has a value of 6·40 milligals per 100 ft. for rock of density 2·5 gm./c.c. If no anomalous mass is present, the resultant gradient is 9·41–6·40 = 3·01 milligals per 100 ft. If the accuracy of the gravimeter is ± 0·7 milligal at each of two stations spaced 100 ft. apart, that is, ± 1·0 milligal in the difference, the accuracy of the second component of the gravity gradient will be ± 1·0 in 6·40, or ± 15 per cent. This will lead to a similar error in the deduced density. The accuracy can be improved by increasing the separation of the stations, if the rock layer is sufficiently thick, or by improving the accuracy of the gravimeter.

The field-test of the gravimeter took place during two days, February 2 and 3, 1952. The first, while showing up various defects in the gravimeter, did not give reliable measurements. The results of the second day's working are shown graphically in Fig. 1.

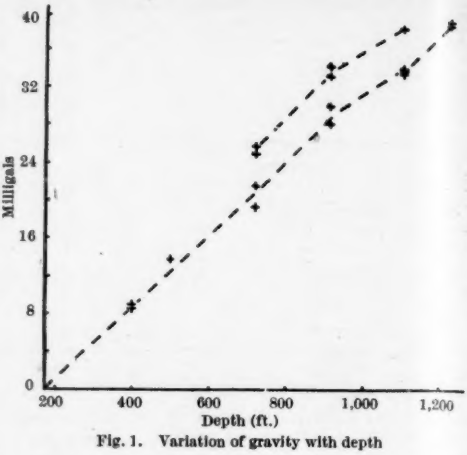

Fig. 1. Variation of gravity with depth

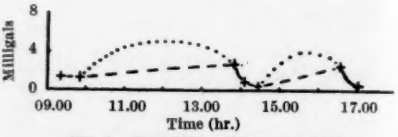

Fig. 2. Zero drift; February 3, 1952

Two runs were made, each starting from a depth of 178 ft., proceeding to 1,226 ft. and returning to 178 ft., stopping at each level marked on the graph in each direction. The 'zero' readings of the gravimeter at 178 ft. are also shown (Fig. 2), and it may be seen that, whereas the initial rate of drift is reasonably low, the zero frequency at the end of each run is different from that at the beginning. The disturbance of the frequency returns towards the original value with a time constant of the order of ½ hr. It is thought that this is probably a thermal effect, and, if so, the true drift was probably as shown by the dotted line. As experimental verification has not yet been obtained, the results given below have been calculated on the assumption of a linear drift as shown by the dashed line.

A surface gravity survey gave no indications of a subterranean anomalous mass and so no anomalous gradient need be suspected. The probable error of a single observation with the gravimeter, derived from repeated observations at each level, is about ± 0·7 milligal. This error, which is much larger than was experienced in the laboratory, is attributable to several causes. The gimbal system was not perfect and this caused some scatter of the readings at each depth. A reversible jump of 4·6 milligals was observed at several stations; this is presumably due to a small piece of dirt alternatively remaining either on the weight or the clamps (see Fig. 1).

Samples of chippings of about 0·1 cm. side were available from the borehole and, although these may not be fully representative of the formations, their densities were measured and averaged over 200-ft. intervals. The error of determination of the densities is estimated at ± 1 per cent.

In the accompanying table, the densities obtained from the chippings, together with those from the gravimeter, are given.

At first sight it would appear that the rock formations are not saturated with water. Final conclusions

Range (ft.)	300–500	500–700	700–900	900–1,100	1,100–1,200
Gravimeter density	2·23±0·08	2·23±0·08	2·14±0·15	2·65±0·15	2·15±0·20
Chippings density (wet)	2·40	2·37	2·25	2·50	2·25
(dry)	2·25	2·17	1·97	2·33	2·0

should not be drawn, however, as the effect of assuming a linear drift of the 'zero' frequency is to indicate a lower density than would be obtained if the alternative drift curve were adopted.

I should like to thank the Anglo-Iranian Oil Co., Ltd., for financial support during the period of research, for permission to publish this communication and for allowing me to use their borehole and for providing a suitable cable and winch for the experiments. I should also like to thank the chairman and members of the Paul Instrument Fund Committee for a grant enabling the gravimeter to be built, Prof. A. O. Rankine for his interest in the work, and Mr. B. C. Browne and Dr. R. I. B. Cooper, of the Department of Geodesy and Geophysics, Cambridge, for their help and encouragement during the investigation.

R. L. G. Gilbert

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June 18.

[1] Smith, *Geophysics*, **15**, No. 4, 605 (1950).
[2] Gilbert, *Proc. Phys. Soc.*, B, **62**, 445 (1949).

Electromagnetic Momentum and Newton's Third Law

The following simple relations[1] between electromagnetic momentum, Poynting's vector of energy flow, and mass–energy equivalence do not appear to have received general recognition in connexion with the validity of Newton's Third Law when applied to electromagnetic forces.

If the dielectric medium is free space, so that there is no matter present to take reactive forces, we suppose that the energy represented by the Poynting vector, $\vec{\varepsilon} \times \mathbf{H}$ (rationalized M.K.S. units), moves with the velocity of light and also has mass of amount m per unit volume of the field. Suppose also that its momentum per unit volume is $\mathbf{D} \times \mathbf{B}$ (where $\mathbf{D} = \varkappa_0 \vec{\varepsilon}$, $\mathbf{B} = \mu_0 \mathbf{H}$, $\varkappa_0 \mu_0 = 1/c^2$), and consider a unit area of surface normal to the direction of energy flow. Then if the rate at which energy passes through this surface is $|\vec{\varepsilon} \times \mathbf{H}|$, it follows that the amount of *moving* energy per unit volume of the field is $W = |\vec{\varepsilon} \times \mathbf{H}|/c$. Its momentum is mc, so if this is to be equal to $|\mathbf{D} \times \mathbf{B}|$, we must have:

$$m = \frac{|\mathbf{D} \times \mathbf{B}|}{c} = \frac{|\vec{\varepsilon} \times \mathbf{H}|}{c^3} = \frac{W}{c^2},$$

which is the mass–energy relation.

Whenever the total 'ponderomotive' force on an electromagnetic system is not zero, it is equal to the volume integral of $-\frac{\partial}{\partial t}(\mathbf{D} \times \mathbf{B})$ taken over the whole of the dielectric in which $\mathbf{D}$ and $\mathbf{B}$ exist. It is therefore balanced by the volume integral of $\frac{\partial}{\partial t}(\mathbf{D} \times \mathbf{B})$, the time-rate of change of the total electromagnetic momentum. The interpretation is clearly that this represents the rate of change of ordinary mass-momentum of the energy which is moving about in the changing field, and that the 'equal and opposite' reaction to the unbalanced ponderomotive force is borne by the energy photons.

Newton's Third Law is thus reinstated if the mass of the field energy is taken into account. The theorem applies both to radiating and to non-radiating systems. A simple example of the latter is to be found in the case of a charged particle moving with uniform velocity through a constant-current toroidal coil.

E. G. Cullwick

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Dundee. March 21.

[1] See, for example, Lorentz, H. A., "Lectures on Theoretical Physics", 241 and 249 (English trans., Macmillan, 1931), in the chapter on "The Inertia of Energy".

Screw Dislocations in Pyrite

In the course of an investigation into the surface structure of a wide range of mineral crystals, the results of which were reported to the Mineralogical Society in March 1951, a number of screw dislocations were observed on the cube faces of one crystal of pyrite, FeS_2. Fig. 1 shows a single screw dislocation; while Fig. 2 exhibits a pair of screw dislocations of opposite sense, which ultimately form an almost closed step-line. The crystal was photographed using a metallurgical microscope, with bright-field illumination, and the surfaces were not silvered. Under these conditions, the very high visibility of the steps forming the main spiral patterns indicates that the layers are multimolecular. This point is further substantiated by the presence of some much thinner layers between the main steps. Examples of screw dislocations with a Burgers vector greater than unity, often considerably greater, have already been reported for cadmium iodide[1], silicon carbide[2], and muscovite[3].

Fig. 1 (× 35)

Fig. 2 (× 35)

The incompleteness of the spiral patterns in Fig. 2 appears to be due to the separation of the thickest layers into several thinner ones in some places.

Note added in proof. A paper on the surface structure of crystals is to be published in the *Mineralogical Magazine*.

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July 8.

[1] Forty, A. J., *Phil. Mag.*, **42**, 670 (1951).
[2] Verma, A. R., *Nature*, **168**, 430 (1951).
[3] Amelinckx, S., *Nature*, **169**, 580 (1952).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, September 8—Tuesday, September 9

FARADAY SOCIETY (at the University of Toronto, Toronto, Canada).—General Discussion on "The Reactivity of Free Radicals".

Wednesday, September 10

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. A. W. Paxton: "Mud Control in the Fields of the Iraq Petroleum and Associated Companies".*

Thursday, September 11—Friday, September 12

MIDLANDS SOCIETY FOR ANALYTICAL CHEMISTRY (at the University, Birmingham), at 9.30 a.m. each day.—Symposium on "Analytical Chemistry".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHIEF SUPERINTENDENT OF THE LONG RANGE WEAPONS ESTABLISHMENT, Salisbury, South Australia, to undertake the overall direction and control of the L.R.W.E. which includes certain laboratories at Salisbury and ranges near Woomera—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (September 15).

PRINCIPAL SCIENTIFIC OFFICER at the Propulsion Research Laboratory, Salisbury, South Australia, for supervising a chemical section for research and investigations related to materials for rocket motors and rocket propellants—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (September 15).

SENIOR SCIENTIFIC OFFICER at Royal Aircraft Establishment outstation at Woodbridge, to study problems arising out of the marshalling and landing of aircraft; design, conduct and evaluate full-scale experiments to define principles of methods for achieving high rate of safe handling using electronics or other flying aids; prepare functional specifications for components of such systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.226/52A (September 15).

HEAD OF THE DEPARTMENT OF MECHANICAL AND ELECTRICAL ENGINEERING—The Principal, Wigan and District Mining and Technical College, Wigan (September 17).

LECTURER (high academic and research qualifications essential) IN CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (September 19).

ASSISTANT LECTURER (temporary) IN PHYSIOLOGY—The Registrar, The University, Sheffield (September 20).

DEMONSTRATOR IN ZOOLOGY—The Registrar, The University, Leeds 2 (September 20).

RESEARCH OFFICER (Plant Pathologist) IN THE DIVISION OF PLANT INDUSTRY, Canberra, for plant physiology investigations relating to plant growth—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3959 (September 27).

LECTURER (with a university degree in either metallurgy, chemistry or chemical engineering, and experience in industry) IN THE DEPARTMENT OF CHEMICAL ENGINEERING at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

LECTURER IN VETERINARY PHARMACOLOGY—The Registrar, The University, Liverpool (September 30).

SENIOR LECTURER IN ANIMAL PRODUCTION at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

VETERINARY OFFICERS and RESEARCH OFFICERS IN THE MINISTRY OF AGRICULTURE AND FISHERIES—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 130–173/52 (September 30).

SENIOR LECTURERS or LECTURERS (Grade II) IN PHYSICS, CHEMISTRY AND BIOLOGY, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (October 1).

UNIVERSITY LECTURER IN BOTANY (with special responsibility for teaching and research in plant bacteriology)—Dr. S. Smith, Department of Zoology, Downing Street, Cambridge (October 1).

RESEARCH OFFICER IN THE DIVISION OF PHYSICAL AND ANALYTICAL CHEMISTRY of the National Chemical Research Laboratory in Pretoria, to supervise the analytical work of the Laboratory and carry out research work in the field of inorganic chemistry—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, October 8).

HERBARIUM ASSISTANT (First Assistant on the staff of the Bolus Herbarium), University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

PROFESSOR OF STRUCTURAL ENGINEERING at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 25).

PHYSICIST (with a first- or second-class honours degree) in a section engaged on a long-term study of the mechanisms of drainage and drying as applied to the papermaking machine—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

RESEARCH INVESTIGATOR for interesting metallurgical investigations of a new welding problem, and a JUNIOR CHEMIST to assist in routine and special analyses of steels and light alloys and the determination of dissolved gases by a high-vacuum technique—The Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

SENIOR SCIENTIFIC OFFICER at Experimental Flying Establishment near Salisbury, to take charge of section dealing with complete design and testing of aircraft instruments and test methods, to advise on methods of measurement of physical quantities in aircraft flight, and to give guidance to aircraft industry in methods for maintenance and calibration of instruments used in acceptance test flying—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.232/52A.

TECHNICAL ASSISTANT (university or similar qualification in chemistry desirable) as secretary to committees dealing with various aspects of chemical standardization—The Establishment Officer, British Standards Institution, 24 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scottish Marine Biological Association. Collected Reprints, 1951. Papers 57–87. (Millport: Marine Station, 1952.) [215

Annual Report and Transactions of the Yorkshire Philosophical Society for the Year 1951. Pp. 17. (York: Yorkshire Philosophical Society, 1952.) [215

Department of Scientific and Industrial Research: Pest Infestation Research. Detection of Insects by their Carbon Dioxide Production. By R. W. Howe and T. A. Oxley. Pp. ii+20. (London: H.M. Stationery Office, 1952.) 1s. net. [215

John Innes Leaflet No. 11: Artificial Illumination of Seedlings. Pp. 8. (Edinburgh and London: Oliver and Boyd, Ltd., 1952.) 9d. net. [265

Units and Standards of Measurement employed at the National Physical Laboratory. 3: Electricity; Current, Voltage, Resistance, Power, Energy, Inductance, Capacitance, Frequency, etc. Pp. 14. (London: H.M. Stationery Office, 1952.) 9d. net. [265

Other Countries

Institut Royal des Sciences Naturelles de Belgique. Mémoires, Deuxième Série, Fasc. 40: Revision de la famille des Alcyonide; le genre Sinularia May 1898. Par Andrée Tixier-Durivault. Pp. 146. Mémoires, Deuxième Série, Fasc. 41: Holothuries de l'Institut Royal des Sciences Naturelles de Belgique. Par Gustave Cherbonnier. Pp. 65+28 plates. Mémoires, Deuxième Série, Fasc. 42: Les Ammonites du Bajocien de la region frontière Franco-Belge (Bord Septentrional du Bassin de Paris). Par Dr. Pierre L. Maubeuge. Pp. 104+16 plates. Mémoires, Deuxième Série, Fasc. 43: Résultats scientifiques des Croisières du Navire-École Belge *Mercator*, Vol. 5. Pp. 23. (Bruxelles: Institut Royal des Sciences Naturelles de Belgique, 1951.) [205

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Bulletin of the Madras Government Museum. New Series, General Section, Vol. 6, No. 1: Possible Sumerian Survivals in Toda Ritual. By H.R.H. Prince Peter of Greece. Pp. xvi+25+10 plates. (Madras: Government Press, 1951.) 6.4 rupees. [215

Fisheries Research Board of Canada. Bulletin No. 93: The Status of the Harbour Seal in British Columbia, with particular reference to the Skeena River. By H. D. Fisher. Pp. iv+58. (Ottawa: Fisheries Research Board of Canada, 1952.) 50 cents. [215

Journal of the Fisheries Research Board of Canada. Vol. 8, No. 6: Limnology and Trout Angling in Charlotte County Lakes, New Brunswick. By M. W. Smith. Pp. 383–452. (Ottawa: Fisheries Research Board of Canada, 1952.) [215

South Australia. Report of the Museum Board, 1st July 1950 to 30th June 1951. Pp. 7. (Adelaide: Government Printer, 1951.) [215

Union Géodésique et Géophysique Internationale. IX^e Assemblée générale: Comptes rendus. Pp. 30. (Bruxelles: Union Géodésique et Géophysique Internationale, 1952.) [215

Smithsonian Miscellaneous Collections. Vol. 117, No. 7: Host Relationships of Moths of the Genera Depressaria and Agonopterix, with Descriptions of New Species. By J. F. Gates Clarke. (Publication 4083.) Pp. ii+20. Vol. 117, No. 8: The Sand Crab *Emerita talpoida* (Say) and some of its Relatives. By R. E. Snodgrass. (Publication 4086.) Pp. ii+34. (Washington, D.C.: Smithsonian Institution, 1952.) [265

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 106, Nos. 8 and 9: Foraminifera Ecology off Portsmouth, New Hampshire, by Fred B. Phleger; and Foraminifera Species off Portsmouth, New Hampshire, by Frances L. Parker. Pp. 313–424+6 plates. (Cambridge, Mass.: Harvard College, 1952.) [265

Catalogues

B.D.H. Concentrated Volumetric Solutions. Pp. 4. (Poole: British Drug Houses, Ltd., 1952.)

Marconi Instrumentation. Vol. 3, No. 5, May. Pp. 69–88. (St. Albans: Marconi Instruments, Ltd., 1952.)

Laboratory Specialities: a Selection of Recently-developed Equipment for use in the Modern Laboratory. (Catalogue No. 16B-8.) Pp. 64. (London: Griffin and Tatlock, Ltd., 1952.)